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Analysis of Demand and Supply for Secondary Fiber in the U.S. Paper and Paperboard Industry

Arthur D. Little, Inc.

Prepared For
Environmental Protection Agency

October 1975

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ANALYSIS OF DEMAND AND SUPPLY FOR SECONDARY FIBER IN THE U.S. PAPER AND PAPERBOARD INDUSTRY

Volume Two

Section IX - Process Economics

Prepared for

Office of Solid Waste Management Programs
Environmental Protection Agency
Washington, D.C. 20460

Under Contract No. 68-01-2220

Attention: Project Officer
Resource Recovery Division (AW463)

March 1975

(Revised October 1975)

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16. Abstracts

This report will be of interest to all concerned with the economics of the pulp, paper and paperboard industry. Although no formal model of the industry is developed, a number of economic evaluations are presented. Moreover, the report presents an extensive compilation of technical and economic data on the U.S. Pulp and Paper Industry with specific attention to the role of secondary fiber. This data provides an assessment of technical and economic potential for increased secondary fiber use in the manufacture of paper and paperboard.

The report is divided into 10 Chapters plus appendix material. These chapters are as follows: (1) Summary; (2) Introduction; (3) Characteristics of the Paper Industry; (4) Wood Resource Considerations; (5) Characteristics of the Waste Paper Industry; (6) Waste Paper Costs; (7) Availability of Waste Paper;

(continued on supplemental pg.)

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(8) Substitutability of Waste Paper; (9) Process Economics; and (10) Potential for Secondary Fiber Use: 1973-1983. The Appendix (Volume 3) contains six sections: (A) Regional Industry Data; (B) Supporting Data for Pulpwood; (C) Supporting Data for Waste Paper; (D) Supporting Data for Process Economics; (E) Glossary; and (F) U.S. Associations in the Paper and Allied Trades.

Volume 1 (Chapters 1-8 and 10 will be of most use to those seeking an overall appraisal of recycling and its role in the industry. Volume 2 (Chapter 9) contains detailed data on the process economics of various subsectors of the paper and paperboard industry.

Process economic data is provided for virgin, secondary fiber, and blend mills for one or more grades of paper, board, or pulp within each of the following sectors of the industry: containerboard; groundwood papers; tissue and other machine creped paper; folding boxboard; printing and writing papers; industrial packaging converting and miscellaneous papers; construction papers; market pulp; and slush pulp. Volume 3 will be of interest only to those groups seeking a more comprehensive understanding of the way in which the various process economic tabulations were compiled.

The following pages in Volume Two are blank:

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DATA BASE

When the data center was managed by Jay Pursell. Cliff Johnson was appointed Data Base Administrator. He made a study of existing software and selected IDMS, which is now up and running. Cliff reported IDMS was extremely easy to use, and takes fewer resources than DL/I. Two other people have now become familiar with it, and will work on the A/R system. Both Cliff and Sid felt strongly that IDMS should be the basis of future systems work. However, they are awaiting corporate approval to use IDMS more aggressively. Bill Bindrim feels he is too new to make a judgment on the issue. He believes that for the long range, there should probably be a large computer in Chicago, interfacing with minis in the plants. He has no plans for upgrading equipment, and thinks in terms of off-loading to other centers if the need arises.

Cliff also reported that he originally thought Task-Master was preferable to CICS, but has recently changed his mind due to CICS enhancements. Also the use of DL/I would require tape and core upgrades to the equipment. The CAMP interface for IDMS-CICS has just been installed. Cliff has not evaluated the IDMS-DBOMP bridge and probably will not get to do so until October.

MATERIAL RECEIVED

- Organization Chart
- System Development Project Schedules
- B/M File Layout
- IDMS A/R Schema Listing
- Cliff Johnson's Data Base Study

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IX. PROCESS ECONOMICS

This section presents the economic models for selected pulp, paper, and paperboard manufacturing operations. Plant investment and operating cost schedules are shown for the manufacture of these selected products from virgin, secondary, and blends of secondary and virgin fibers.

The information presented here was developed from in-house information and from consultation with Charles T. Main, Inc., whom we retained as advisor for this segment.

A. BASIS OF ECONOMIC ANALYSIS

1. Monetary Base

Because plant investment and operating costs have been escalating rapidly in recent months, we have based our economic models on mid-second-quarter 1974 costs. Further, because of the uncertainty of future prices, all of our analyses are based on second-quarter 1974 conditions without any escalation for further inflation. However, we have indicated in a qualitative manner what the recent cost (price) trends have been for major cost elements and their likely future performance.

Wherever it was reasonable to do so, we have used actual second-quarter 1974 costs and selling prices. For some waste paper grades (e.g., No. 1 News and OCC), where second-quarter conditions were particularly unstable, we have estimated more realistic price levels in terms of second-quarter dollars. In the case of product categories, whose selling price varies widely with product quality, we have estimated a second-quarter price that reflects this.

2. Units of Measurement

The metric system of measurements has been used as the standard for this report. All units are reported on this basis, with two exceptions: to remain consistent with standard cost and physical properties data, we have reported wood cost and consumption in cunits* and energy cost and consumption in millions of Btu**.

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*One cunit equals 100 cubic feet, or approximately 2.83 cubic meters, of solid wood. It also equals approximately 1.20 cords of softwood or 1.27 cords of hardwood.

**One million Btu equals approximately 0.252 million kilocalories.

Other units and terms used in the cost models which should be noted are:

ADMT: Air-Dried Metric Ton (90% solids, 10% moisture)

MDMT: Machine-dried Metric Ton (92% to 95% solids, 5% to 8% moisture, depending on product)

BD: Bone Dry (100% solids)

3. Selection of Economic Models

Specific paper and paperboard products were selected from each of the principal functional groups for economic analysis. The selection was based upon the relative importance of the specific grade (i.e., its tonnage), its ability to accommodate secondary fiber, and the competitive position of a recycled product vs. a virgin fiber product for a studied application. For example, secondary fiber is not used in the manufacture of solid bleached sulfate board (SBS), but as it competes with recycled clay-coated board in a number of folding boxboard applications it was included in the economic analysis. The process economics position of virgin vs. S/F, and hence their competition for specific grades, can be quite dissimilar; accordingly, in many of the functional groups more than a single product was selected for analysis.

Note also that while we have compared the costs of products made from virgin vs. recycled fiber, in many instances these products are complementary and not necessarily in direct competition for a selected end-use. In the discussions of the specific economic models, we have noted which are complementary and which are in direct competition. Table IX-A-1 indicates the products that were selected for economic modeling.

4. Characteristics of the Economic Models

The cost models have been developed for a typical scale of operation and extrapolated to show how changes in design capacity affect the cost. All costs are based on mills operating at their design capacity; thus, a decrease in scale of operation represents a smaller mill, not one running at less than 100% of capacity.

All cost models are developed for new mill installations, typical of good technical practice in 1974. For integrated operations, this could be the cost of a new paper machine added to an existing pulp mill, but not the cost of incremental capacity expansion or mill upgrading. None of the models represent the costs of an actual mill.

For virgin fiber pulping, we have taken a relatively large capacity, considered economical by 1974 standards, but not the largest possible. For papermaking operations integrated to virgin pulping, we have selected the largest practical size for a single machine, as this is typical of current installations. For nonintegrated secondary fiber operation, we have selected a single machine capacity lower than the largest practical; this is representative of the existing industry, since the

TABLE IX-A-1

ECONOMIC MODELS ANALYZED

Functional Group*	See Section	Virgin	100% S/F	Blend Virgin + S/F
1. Containerboard	E			
Liner		x	x	x
Medium		x	x	x
2. Groundwood	F			
Newsprint		x	x	x
Publication		x	x	x
3. Tissue	G			
Toilet/Facial		x	x	x
4. Folding Boxboard	H			
18 Pt. Clay-coated		-	x	-
SBS		x	-	-
5. Printing and Writing	I			
Bond		x	x	x
Book		x	x	x
6. Industrial & Converting	J			
Unbl. Bag		x	x	x
Tube		x	x	x
7. Construction Paper	K			
Roofing Felt		-	-	x
8. Market Pulp	L			
Bl. SW Kraft		x	-	-
Bl. HW Kraft		x	-	-
Recycled Fiber				
Unbl. Kraft from OCC		-	x	-
Groundwood from Old News		-	x	-

*Not included in the functional groups (but presented in Section M) are economic models for bleached and unbleached kraft and groundwood slush pulp manufacture.

economic availability of secondary fiber rather than machine size alone is the limiting factor in plant capacity.

We have defined mill capacity on a daily tonnage basis, and calculated annual capacity as daily capacity multiplied by net operating days per year. The latter are total days of actual mill operation per year after subtracting scheduled down-time for holidays and estimated maintenance shutdowns. In all cases, we have allowed 7 days for scheduled maintenance and 4 days for holiday shutdowns, giving a net on-stream time of 354 days per year. We have allowed seven total paid holidays and assumed that the mill would operate on three of them. Of the 354 on-stream days, we have estimated that commodity grades (newsprint, board products, corrugating medium, and market pulp) would have a total productive operation of 340 to 345 days. For noncommodity grades, plus jute liner and bogus medium, we have estimated 330 productive days to reflect more frequent clean-up and grade changes.

Plant site selections have been consistent with existing paper industry patterns. For products where a number of geographic areas could be considered typical, we have concentrated our models in one area to emphasize fiber furnish and product grade as the primary variables in cost and profitability estimates.

A large portion of the kraft pulp sector is located in the Southeast, where costs differ considerably from those in other areas. We have found it more typical to locate our models for bleached kraft paper grades in the Northeast; however, bleached softwood and hardwood kraft pulp models have also been prepared for the Southeast to indicate the influence of plant location on the cost of these products.

5. Nature and Precision of Specified Conditions

To prepare our cost estimates, we have had to make specific judgments regarding operating and selling conditions for each model. Some conditions are affected by plant location: for example, the cost of fuel and power, the cost of virgin and secondary fiber, and the availability of virgin fiber as roundwood or chips. Other conditions are affected by plant size, such as whether it is more economical to generate or to purchase power. (See Section C.)

Some conditions are more arbitrary. Manning requirements, maintenance, utility consumption, chemical usage, fiber yield, and factory overhead can vary considerably from one mill to another for the same product and capacity. Selling price, sales expense, general administration costs, and freight (as affected by the distribution of customers) are all influenced by individual company characteristics. Our models are based on the use of a single paper machine; however, the same amount of a product could be made on two or more smaller machines at significantly different cost. While we have made every effort to select typical conditions, different but equally valid assumptions can be made which could also be considered typical.

Effluent treatment costs are particularly variable with respect to plant size, location, and site specifics, as well as with effluent standards. We have attempted to include typical costs based on 1977 guidelines, which include primary and secondary treatment but exclude tertiary treatment or color removal. We have selected an aerated stabilization basin as opposed to activated sludge as the most economical method for secondary treatment in all models. However, site differences would affect this assumption, and actual effluent treatment costs could vary widely from any typical model.

In addition to variations from the conditions we have specified, there is an inherent lack of precision in estimating present costs, or updating historical costs, when economic conditions are fluctuating rapidly. To acknowledge the effects of variations due either to different assumed conditions or precision of estimates, we have calculated and presented graphically the sensitivity of total delivered cost (manufacturing cost) and profitability (return on fixed capital) to variations in selected key variables.

One of the key variables is scale of operations (plant capacity). Two points should be noted: (1) we have held to a single machine operation for all capacities, and (2) the source of power at all other capacities is the same as the base-level model, whether purchased or generated.

Each group of models for a particular product is summarized in a preceding "Economic Comparison" table. It is the intent of these comparisons to present the data from comparable models so that differences among them may be seen readily. However, the specific assumptions made for each model also apply to these summary comparisons. Variations in any of the assumptions and conditions, most notably scale of operations and secondary fiber prices, will result in considerable differences in the comparative economics for any group of models.

In comparing the relative attractiveness of the models as an investment opportunity, one must consider the actual magnitude of total capital requirements, as well as changes in the design conditions and variations around those conditions as expressed in the sensitivity charts for delivered cost and pre-tax return on fixed capital.

6. Slush Pulp Cost

Virgin fiber kraft pulp is the basis for several paper and board grades as well as for market pulp. Because any combination of drying and papermaking operations may be integrated to kraft pulping, papermaking capacity for a given product is independent of pulp mill capacity. For this reason, we have found it convenient to develop a total factory operating cost for bleached kraft slush pulp as a raw material input to papermaking operations. The base-level slush pulp cost is related to a particular pulp mill capacity, specifically 730 ADMT/day. We have defined slush pulp cost by subtracting converting and capital costs allocated to pulp drying from total factory operating cost in our 730-ADMT virgin market-pulp models.

Associated with the slush pulp are the potential utilities (steam and power generation, water supply, and effluent treatment) allocated to pulp drying. Figure IX-A-1 represents this relation graphically. To use this potential for utility supply it is necessary to include allocated investment and operating costs with the papermaking operation. Thus, the investment and operating cost schedules for integrated papermaking include the total amounts directly associated with forming (stock preparation, machine, dryer, and roll finishing) plus allocated amounts for utilities and auxiliary facilities shared with the kraft pulp mill. For example, the investment for steam and power generation in an integrated paper mill is an allocated portion of a larger recovery boiler, power boiler, and turbine generator.

In addition to shared physical facilities, integrated papermaking operations also have the benefit of sharing many of the costs included with factory overhead. We have reflected this by developing an overhead schedule for a 730-ADMT/day market pulp mill, which provides the basis for factory overhead costs on all models integrated to bleached kraft pulping.

The factory operating cost for slush pulp as transferred to integrated papermaking also includes the capital-related costs for pulping, whereas the investment schedule for papermaking includes only the capital allocated to or directly associated with the paper mill. To determine the total capital employed, we must add a portion of the pulp mill investment, proportional to the amount of slush pulp transferred to a given papermaking operation. We have estimated this by calculating investment per daily ADMT of slush pulp for our 730-ADMT kraft pulp models.

In a similar manner, virgin groundwood pulp at 400 ADMT/day and unbleached kraft softwood pulp at 730 ADMT/day are also the basis for several paper and board grades. We used the same technique of developing a slush pulp transfer cost to an integrated papermaking operation. Thus, in calculating profitability (ROI), the pulp mill investment associated with that quantity transferred to the papermaking operation was added to that for the paper mill to obtain total capital requirements.

The use of this modular approach in developing the process economics results in a single entry for slush pulp cost in those economic examples in which the pulp mill size is disproportionate to the papermaking operation. Accordingly, if we were to postulate a change in the energy cost for newsprint manufacture, we would have to determine its effect on slush pulp cost as well as on the papermaking operation. (See p. IX-M-1).

In presenting the sensitivity of delivered cost and profitability to variations in fixed capital for those models which use slush pulp, only variations in the capital associated with papermaking are considered. For delivered cost, the capital related costs associated with slush pulp are considered as part of slush pulp as a raw material cost. For profitability, the return is calculated on total fixed capital for slush pulp

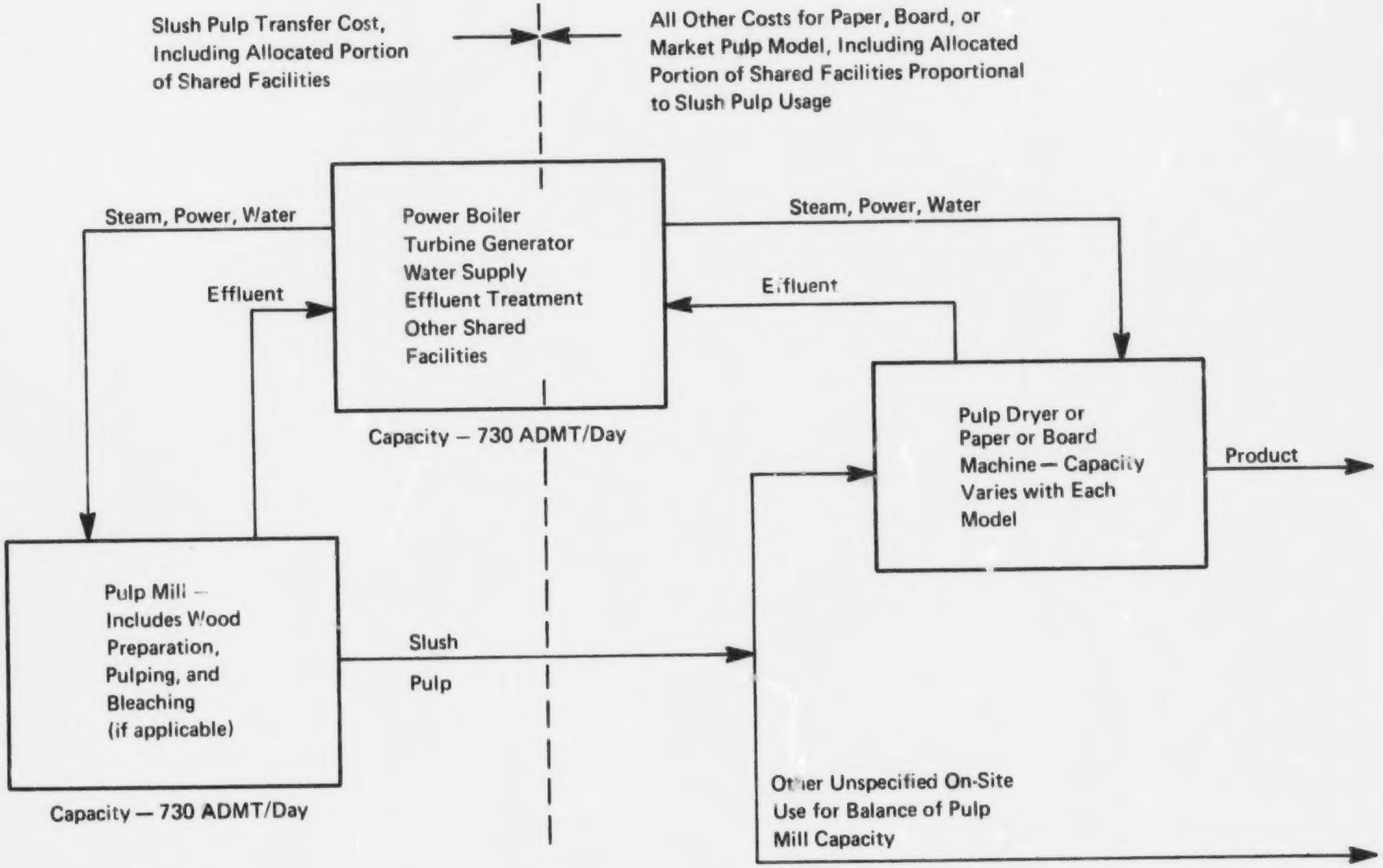
Slush Pulp Transfer Cost, Including Allocated Portion of Shared Facilities
All Other Costs for Paper, Board, or Market Pulp Model, Including Allocated Portion of Shared Facilities Proportional to Slush Pulp Usage
Steam, Power, Water
Effluent
Power Boiler
Turbine Generator
Water Supply
Effluent Treatment
Other Shared Facilities
Capacity – 730 ADMT/Day
Steam, Power, Water
Effluent
Pulp Dryer or Paper or Board Machine — Capacity Varies with Each Model
Product
Pulp Mill — Includes Wood Preparation, Pulping, and Bleaching (if applicable)
Capacity — 730 ADMT/Day
Slush Pulp
Other Unspecified On-Site Use for Balance of Pulp Mill Capacity

FIGURE IX–A–1 DEFINITION OF SLUSH PULP COST AND ALLOCATION OF COST OF SHARED FACILITIES FOR INTEGRATED MILL COMPLEX

plus papermaking, but the capital associated with slush pulp is held constant and variations are considered only for the capital associated with papermaking.

Appendix D-8 lists the moisture content used in each model and the raw material for the papermaking operation (i.e., pulpwood or slush pulp). Where slush pulp was used, a portion of the pulp mill was allocated to the investment for the papermaking operation to derive ROI.

B. CAPITAL REQUIREMENTS

1. Total Fixed Capital

We have developed "budget" estimates for the construction of new plants for each of the selected paper and paperboard products. These estimates are based upon our in-house information, supplemented by information from Charles T. Main, Inc. Since budget estimates are generally understated, the likely range of precision is +25%/-10% -- i.e., they could be low by as much as 25% or high by as much as 10%.

Total fixed capital is the total of physical plant cost plus other fixed capital. Capital cost schedules have been developed for a typical size mill for each product studied. Extrapolations of the fixed capital requirements to smaller and larger facilities are shown in Appendix D-7.

We have allocated the capital cost to each major process step; e.g., wood preparation, pulping, and papermaking. The cost distribution for the process equipment is apparent, but the allocation for "shared facilities" (steam and power generation, shops and stores, etc.) is more complicated. Where possible, the cost of "shared facilities" has been allocated according to the usage of that facility by the individual process step. For example, the investment for steam and power facilities is allocated to wood preparation, pulping, etc., on the basis of their respective requirements for steam and power. On the other hand, investment for other shared facilities, such as laboratories or shops and stores, is allocated on the basis of the direct capital cost for the process step. Obviously, the latter is a judgmental allocation, and other techniques could have been used.

We have not included capital costs for woodlands operations in any of our capital estimates. Where a woodlands position exists, its capital and operating costs, as well as profitability, are reflected within the cost of wood as delivered to the mill site.

a. Physical Plant Cost

The physical plant cost consists of the direct plant cost plus the estimated cost of construction supervision and overhead, engineering, and an allowance for contingencies. Direct plant cost is the installed cost of purchased equipment, buildings, and site work, excluding the bare cost of land. Each plant item includes purchased equipment and building materials, piping, instrumentation, electricals, structures, foundations, and associated labor costs. Tables showing the components of the direct plant cost are presented in Appendix D for each product considered.

b. Other Fixed Capital

We have also estimated the additional capital cost items, (spare parts, pre-startup and startup costs, project management, etc.) that normally are associated with a new venture but not included in the physical plant cost.

2. Working Capital

Experience has demonstrated that the working capital required for:

- raw materials,
- goods in process,
- inventory, and
- accounts receivable (less accounts payable)

is generally equivalent to three months' production at total factory cost. Accordingly, we have estimated working capital requirements on this basis.

C. OPERATING COST ESTIMATES

We have prepared operating cost schedules for all the products listed in Table IX-A-1. As with the plant investment estimates, the costs are developed for a typical size facility. Graphs (see Appendix D) have been prepared to illustrate the effect of operating scale on these costs. As with the investment schedule, operating costs have been developed for virgin fiber and secondary fiber manufacturing facilities, and for facilities that utilize secondary fiber to supplement a virgin fiber supply.

Table IX-C-1 summarizes the unit costs used in the economic models.

1. Raw Materials

This includes all raw materials for manufacture, net credit for any byproduct recovery, and auxiliary materials such as chemicals for water and effluent treatment.

TABLE IX-C-1

SUMMARY OF COSTS USED IN ECONOMIC MODELS

Item	Basis	Unit	Unit Cost ($) North-east	 North Central	 South	 Pacific N.W.	Supporting Data
RAW MATERIALS							
Pulpwood:							
Rough-Softwood	Del'd Price	Cunit	41	32	32	N.A.*	Section IV
Hardwood		Cunit	37	27	27	N.A.*	
Wood Chips-Softwood		Cunit	41	N.A.**	32	38	
Hardwood		Cunit	37	N.A.**	27	25	
Waste Paper:							
Old Corrugated Containers							
OCC	Del'd Price	M.T.	50	55	60	55	Sections V and VI; Appendix C-1
Dbl. Kraft Lined Corr. Cuts		M.T.	70	75	75	75	
News							
No. 1 News		M.T.	45	40	45	40	
Pulp Substitutes							
Ledger		M.T.	157	140	135	130	
Manila Tab Card		M.T.	230	270	320	250	
Unbleached Kraft Grades		M.T.	100	95	95	95	
Mixed Waste Paper							
No. 1 Mixed		M.T.	25	30	30	30	
Chemicals	Estimated separately for each paper grade						Appendix D-1
CONVERSION (Less Capital-Related)							
Average Labor Rate:							Appendix D-3
Direct		Man-hr	4.8	5.2	5.5	6.2	
Maintenance		Man-hr	5.5	6.0	6.4	7.1	
Fringe Benefits @ 32% of Hourly Rate							Appendix D-2
Supplies: Operating Packaging Maintenance	Estimated separately for each paper grade						
Utilities:							Appendices D-5, D-6
Fuel	Del'd Price	MM Btu	2.0	1.8	1.0	1.1	
Power	Purchased	kWh	0.021	0.017	0.012	0.011	
Factory Overhead	Schedule constructed for each basic economic model and extrapolated as a percentage of direct labor requirement for variations from the basic models.						
CAPITAL-RELATED							
Depreciation:							
Building - 33 years, i.e., 3%	[weighted avg. est. 75% equipment and 25% building = 5.4% Total Fixed Capital]						
Equipment - 16 years, i.e., 6-1/4%							
Local Taxes and Insurance	@ 2-1/2% Plant investment annually						
COST OF SALES							
G & A Sales Expense	Reported as % of product selling price						
Freight	Estimated for each paper grade						

* Rough wood not applicable in Pacific Northwest.

** Use of wood chips in North Central region is insignificant.

a. Pulpwood

Requirements for pulpwood or other cellulosic raw material are developed via a material balance that takes into account such factors as wood densities, pulping yields, and process losses.

b. Slush Pulp

The total factory operating cost of slush pulp (as defined in Section A.6) is considered as a raw material cost for any papermaking operation integrated to a pulp mill which can provide furnish for more than one product line.

c. Pulping and Papermaking Chemicals

The material balance also includes estimates of the pulping and papermaking chemical requirements for the studied pulp and/or paper product. The unit prices used are tabulated in Appendix D. Where applicable, chemical by-products (turpentine and tall oil) are indicated. In addition, the summary material balance indicates the quantity of residue fuel generated in the conversion of wood to pulp (or paper). The amount of residue fuel is subsequently used in the derivation of an energy balance.

For clarity in the material balance, we have shown typical fresh chemical makeup rates to pulping and bleaching operations, but have accounted only for the fiber output from these operations. Chemical losses are equal to chemical makeup rates less any by-product recovery, and we have not attempted to detail internal chemical recovery and recycling.

For papermaking chemicals, a major portion of the additives become part of the product; thus, we have accounted for papermaking chemical losses and, by difference, papermaking additives recovered with the finished sheet.

d. Other Chemicals

In addition to the pulping and papermaking chemicals that are included in the sample material balance, other chemical raw materials are used in the manufacture of pulp and paper products. These include detergents, slimicides, antifoam agents, retention aids, pitch control agents, water softening agents (or ion exchange resins for boiler feed water treatment), etc. These materials are used in small quantities, but when aggregated they constitute an identifiable cost in the manufacture of a product.

For purposes of analysis, the costs of these materials are combined and reported as a single unit per ton of product. Mill records and our experience have been used to estimate the total cost.

2. Conversion

This includes all factory labor, supplies, utilities, and expense other than raw materials or capital-related costs.

a. Direct and Indirect Labor

Manning tables have been prepared for each of the studied economic models. Many manning schedules are based upon in-house information pertaining to actual mill practice; others are based upon more thorough pre-engineering cost studies that we have prepared for various product areas. Total man-hour requirements are based on 2,068 man-hours per man-year (47 weeks at 44 hours). Holidays and vacations are included in fringe benefits at 32% (included in hourly rate).

b. Maintenance Labor & Supplies

For new plants, the costs of maintenance labor (as well as supplies) are frequently estimated on the basis of plant investment. A total cost for maintenance labor and supplies of about 4% of the new plant investment is typical for pulp and paper manufacture. Industry experience indicates that the total cost is about equally split between materials and labor. Use of the 4% figure is a reasonable method for deriving the maintenance cost for a new plant, but we have chosen to develop a manning table for maintenance labor and to estimate maintenance supplies at 1.5% to 2% of physical plant cost. This specifically excludes any labor or materials associated with capital improvement or replacement projects.

c. Supplies

The operating supply item includes replaceable parts such as felts, wires, lubricating oil and grease, rags, and fuel (for fork lift trucks). Units and unit costs for this entry are not meaningful. In-house mill records and industry records provide the most reliable source of information on this cost for the various pulp and paper grades.

Packaging supplies also vary widely among the paper grades selected for economic analysis. For example, linerboard requires just a core, plugs, and steel strapping; the total cost for these supplies is $0.50 - 1.00 per ton. On the other hand, the supplies used in packaging tissue, which include printed folding boxes and corrugated containerboard, cost about $50 per ton. Accordingly, for most commodity grades (linerboard, newsprint, folding boxboard,etc.), where packaging supplies are a minor item, we have shown a single entry based upon industry practice. For tissue we have made a separate estimate, including packaging supplies, of the cost of converting from jumbo rolls to packaged product.

d. Utilities

The unit requirements for fuel and power have been derived by an energy balance. The balance indicates the consumption of these utilities by major process steps--e.g., wood preparation, pulping, bleaching, and papermaking. The source of energy (bark, black liquor, fossil fuel) also is indicated. In this manner, the quantity of supplementary fossil fuel may be adjusted to reflect alternative assumptions that may apply. Only the portion of the total steam requirement generated from fossil fuel represents an actual fuel cost.

Charges or credits for power represent the cost of power actually supplied from outside sources or, in the case of integrated paper or board production, the value of power credited as an excess in the pulping operation. Whenever total steam requirements for a product (including the combination of pulping and forming for integrated operations) exceed 75,000 kilograms per hour (equivalent to 7,500 kw of power), we have included the cost of an extraction turbine generator in the estimated capital requirements. Thus, for all operations that require at least 75,000 kg of steam per hour, power is generated on-site. All smaller operations use power purchased from external sources. Extracted and purchased power are indicated separately in the operating cost tables.

We have not made a detailed study of the economics of generating vs. purchasing power for each model. The minimum of 7500 kw for on-site power represents our judgment of a reasonable average for second-quarter 1974 conditions; this minimum would, of course, vary from one location to another, depending on regional and local power costs, specific conditions of the mill, and capital cost of generating facilities. Tables of fuel costs and power rates in various parts of the country are included in Appendix D.

No purchase costs are included for water, as we have included the capital, labor, and chemical treatment costs for water supply and effluent disposal in all estimates. This assumption facilitates direct comparison of the estimates, but it should be recognized that smaller secondary fiber mills in urban locations might use municipal facilities for water supply and effluent disposal. In this case, the cost of the water would be \$0.20 to \$0.50 per 1000 gallons (\$0.053 to \$0.15 per cubic meter), with \$0.30 per 1000 gallons (\$0.08 per cubic meter) a typical value.

e. Factory Overhead

Factory overhead includes on-site management, salaried supervision, the salareis of office clerical, technical, and laboratory staff, on-site office and laboratory supplies and expense, and personnel expenses. It excludes off-site overhead, such as corporate administration and sales expense, which are shown as separate non-factory costs. Factory overhead is expressed as a percentage of total labor, direct and indirect (but excluding maintenance labor).

Factory overhead costs for two different types of mills, one non-integrated and the other integrated, are derived in Appendix D-7. (The first is included with the economic model for tissue from 100% secondary fiber, and the second is with the models for bleached kraft market pulp.) By using the ratio of factory overhead to direct and indirect labor costs in the appropriate one of these two examples and making suitable modifications to reflect the characteristics of different mills, we estimated the factory overhead costs for the other models.

3. Capital-Related

a. Depreciation

We have assumed straight-line depreciation in our cost calculations. For new mills, the rate is derived by taking the weighted average of equipment and buildings at 16 and 33 years respectively. Typically, equipment constitutes about 75% of the new plant investment and building 25%, yielding a weighted average annual depreciation of about 5.4%.

b. Interest on Borrowed Funds

Typically, a paper and/or paperboard manufacturer borrows money for both fixed and working capital requirements. The amount varies widely, depending on the mill and the industry sector. To avoid speculation in this area, we have simply indicated the total capital requirements and acknowledged that interest on loans is not included in the derived operating cost estimates.

c. Local Taxes and Insurance

Local taxes on new facilities are typically 2 to 2 1/2% of new investment. Hence, for new facilities, the contribution of this item to operating cost can be derived readily.

4. Cost of Sales

a. General Administration

General administration includes all allocated corporate (non-factory) costs, such as central engineering, purchasing, and research, corporate management and legal staff, office overhead, etc. This cost is affected by the corporate structure, the size of the operation, and the value of the product. Typically, it ranges from about 3% to 10% of the total factory cost; however, it varies widely and is strongly dependent upon the marketing characteristics of the individual product. We relied upon our experience to select a "typical" cost for this item for each of the studied paper and paperboard products.

b. Sales Expense

Sales expense is shown as a separate item, since it can be either a corporate cost for marketing and sales staff and expenses, or an external cost for broker's fee and commission. This item varies widely between functional groups as well as within individual product categories. For example, the cost for this item differs between Tissue and Groundwood (functional groups) as well as within the Groundwood group (newsprint vs. uncoated groundwood paper) product categories.

Obviously, the sales expense for commodity products, such as linerboard, newsprint, or bag paper, is significantly less than that for retail-oriented products such as tissue, printing paper, and writing paper. Moreover, there is also a wide variation within each major category, reflecting the costs associated with marketing brand-name or "private label". We used our judgment to select an appropriate value from within the range of costs experienced by the industry for this item.

c. Freight

The cost of shipping the finished product to market has been estimated on an individual product basis. Variations in freight rates reflect:

- differences in product value;
- industry practices wherein some board grades are exchanged between manufacturers; or
- distribution patterns based on paper grades and mill size. (For example, we used substantially higher freight costs for SBS than for combination board, because SBS mills are characteristically larger and more distant from the metropolitan areas than those that make combination board.)

Again, general industry averages have been used in the analysis of the economic model.

D. INTERPRETATION OF VARIABLES

1. Scale of Operations

We have calculated and plotted the effect of scale of operations on total fixed capital requirements and operating costs for each model. Scale of operations is defined as the mill design capacity, with the mill actually operating at that capacity; it does not apply to a larger mill operating at less than full capacity.

We have selected a high and low point for each model, based on a survey of current industry capacity ranges. Individual cost items from the basic model have been extrapolated to the high and low points of scale of operations, taking into consideration how much each item is affected by capacity. New capital and operating cost totals were determined for two capacities in addition to the basic models, and these have been plotted. In no case did we consider a capacity change greater than 50% of the basic model capacity. We have drawn curves through the calculated points and extended these over a wider range to indicate the rate of change. However, these curves are primarily intended to determine intermediate points within the calculated range and are less accurate elsewhere.

Two points must be emphasized in the scale-of-operations relationship:

(1) All models at all capacities are based on a single-machine operation. We have not calculated or represented the effect of making the same volume of the same product by using two or more machines.

(2) Whether the basic model has purchased or on-site power, the extrapolations from that model have the same source. Thus, in starting with a small mill based on purchased power, the extrapolation to a larger mill is also based on purchased power without an exact determination of whether this meets our criteria for purchased versus on-site power. Conversely, in starting from a larger mill with on-site power generation, the extrapolation to a smaller mill would also be based on generated power.

2. Sensitivity Charts - Delivered Cost

We have calculated and plotted the effect on operating cost of changes in selected key cost variables, including scale of operations. These charts include the possible range of each variable as an actual range and as a percentage change, so that all variables can be plotted against the same scale. The total possible range for each variable is plotted; intermediate values can be read easily by expressing the change in a variable as a percentage increase or decrease from the best guess, and reading the percentage change directly on the chart.

The sensitivity charts present a clear picture of the relative importance of each variable, both in terms of equal percentage changes and total possible range. They permit a rapid calculation of the effect of changes in design conditions and assumptions, changes due to the accuracy of estimating techniques, or actual changes in the cost data used. For example, a change in fiber cost can be read directly as a new operating cost. The range of operating costs due to the accuracy range of capital estimates can be read directly. For a change in mill location, one can determine the total changes in operating cost resulting from each regional cost factor, as summarized in Table IX-C-1.*

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*For details on the handling of slush pulp cost changes, see p. IX-M-1.

3. Sensitivity Charts - Return on Fixed Capital

The pre-tax return on fixed capital or investment (pre-tax ROI) is shown for each model. Pre-tax ROI is defined as annual profit before income taxes, devided by total fixed capital (but excluding working capital), expressed as a percentage. To derive the fixed capital required for an integrated pulp and papermaking operation, we added the allocated investment for the pulp mill to the estimated fixed capital for the papermaking operation.

We have also calculated and plotted a sensitivity chart for each model to show the effect on ROI of changes in selected key variables. These charts are similar to those described above for delivered cost and are read and used in the same way; however, they emphasize the effect of changes in the variables on the relative attractiveness of a new venture. Specifically, they highlight the importance of selling price in the evaluation of product profitability.

Note that the range in capital requirements for an integrated mill is the result of possible variations for the papermaking operation only, as the allocated investment for the pulp mill is assumed constant. Changes in pulp mill size and other cost variations that may occur in pulp manufacture are reflected as variations in the transfer cost of slush pulp.

E. CONTAINERBOARD

1. Linerboard

a. Basis of Models

Four economic models have been prepared for the production of linerboard from virgin or secondary fiber, and blends of both. As the products from these models serve competitive markets, they must be of approximately equivalent quality. Industry experience* has shown that the inclusion of OCC in linerboard up to 20% of total fiber furnish does not adversely affect product quality or board machine operation; thus, we have used this ratio for the blended models.

In the case of jute liner from OCC, we have chosen an asphalt dispersion system for secondary fiber preparation, in combination with the use of dry-strength additives introduced at the board machine. This method is suitable for making a product from 100% OCC that is comparable to one made from virgin fiber. Several other options are available to improve the quality of linerboard made from secondary fiber: namely, the addition of virgin kraft fiber with dry-strength beater additives (starch), increasing the basis weight of the product for the same selling price (i.e., weight giveaway), and higher energy input in fiber refining. All of these methods, including the asphalt dispersion and chemical additive methods we have chosen, yield a product that will compete with virgin or blended liner.

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* G.T. Edmonds, "Economics of Recycle Usage," TAPPI, Vol. 57, No. 12, December 1974.

In spite of measures taken to improve S/F product quality, the price for jute liner is generally discounted by about $5/ton. This price differential generally prevails in an excess supply situation but is eliminated in a supply-limited market such as existed in 1973 to mid 1974. In our analysis, we used a $5/ton price differential.

Linerboard production from virgin fiber is concentrated in the South and Pacific Northwest, and essentially none is made in the North Central or Northeast regions; therefore, we have chosen a Southeast location for the virgin fiber and blended models as typical of existing industry patterns and potential growth. Regional variations can be evaluated through use of the regional data previously presented (Table IX-C-1 and the sensitivity charts included for each model.

The virgin fiber model is sized at 910 MDMT/day, which is typical of a new installation. The associated pulp mill is assumed to be in balance with the board machine requirements.

Jute liner, the second example, is primarily manufactured in metropolitan areas, with a high concentration in the North Central region. We have used this region for our typical model; the economics of other regions can be determined through the use of the regional data and sensitivity charts. We have selected mill capacity at 300 MDMT/day based on the existing industry characteristics and on our judgment of the availability of fiber at competitive cost to supply a mill. The operation is not limited to 300 tpd by technical considerations.

Two examples of blended liner production are given next. In Case I, the capacity of the mill is 910 MDMT/day; the fiber furnish is assumed to be obtained from a 730-tpd virgin pulp mill and a 180-tpd secondary fiber (OCC) pulping operation. Case II is based on a 910-tpd virgin pulp mill and a 230-tpd secondary fiber pulping operation. Although Case II is based on a new installation and hence simply reflects economy of scale as compared with Case I, it also is indicative of the prospects of adding incremental capacity to a board machine via the introduction of S/F. With some modifications and major capital expenditures, the capacities of some board machines can be increased incrementally, perhaps 5-15% (e.g., 50-150 tpd for a 910-tpd machine). Since it is highly unlikely that the pulp mill would have that much reserve capacity, the incorporation of S/F can provide a convenient method of expanding production. Determining how many machines have this potential incremental capacity and how much the expansion would cost is beyond the scope of this work, as it requires individual engineering studies for each specific installation.

Another alternative which may be postulated in the fiber blend models is to replace some virgin pulp with secondary fiber. Implicit in this approach is that there would be an alternative use for the unbleached kraft liner-grade pulp or that the production of the pulp mill would be curtailed. Again, it is not within the scope of this program to determine how many mills have the potential of diverting their virgin pulp production to alternative uses or the cost for partially curtailing their production. Nevertheless, Case II provides the framework from which the potential costs and profitability may be determined, given the appropriate specific conditions.

b. Comparative Economics

Table IX-E-1 summarizes the capital requirements, operating costs, and profitability of the selected examples.

Total fixed capital for the virgin fiber and two blended models at $110, $106 and $119 million, respectively, includes wood preparation, pulping, and board production with on-site power generation. Total capital at $30 million for the jute liner model is based on up-to-date technology; it includes the asphalt dispersion system discussed previously, a single Fourdrinier board machine, and steam/power generating facilities for on-site power generation.

When we consider that jute liner not only requires a smaller investment than virgin kraft per daily ton of capacity, but also can be economically manufactured on a much smaller scale, we find that there is an order-of-magnitude difference in the fixed capital requirements. The implication of these differences will be discussed in the profitability analysis which follows.

The comparison of operating costs indicates that, based upon the selective assumptions, the delivered cost of jute liner at $169/ton is significantly greater than that of virgin or blended liner.

The most significant difference in delivered cost is the relatively high cost of raw materials for the manufacture of jute liner. Part of the cost difference is due to chemical additives and part to actual fiber cost. This cost difference in raw materials is independent of scale of operations; hence the jute liner facility is not disadvantaged by virtue of its smaller size. However, because the cost of OCC has been extremely volatile recently, we have reflected the result of possible fiber cost changes in the sensitivity charts. At the low end of the cost range for OCC, ($28/ton), the delivered cost of jute liner is much more competitive with both virgin and blended liner. Compared with cost of raw materials, the remaining cost variables are significantly less important.

At second-quarter 1974 costs for OCC ($55/ton), the return on investment for jute liner was significantly lower than that for kraft liner. At current prices for OCC ($28/ton), however, the ROI would be about the same.

If the cost of OCC drops, the blended models have the combined advantage of large scale of operations with decreasing raw material costs, and they become more attractive than virgin liner in terms of both delivered cost and return on capital. Even at the lowest cost for OCC, they are more attractive than jute liner; however, since the blended models are far less sensitive than jute liner to the cost of OCC, the difference narrows as OCC cost decreases.

By virtue of its low total investment, jute liner could be a viable alternative in situations where total capital is limited and there is no opportunity to add incremental capacity to an existing mill, or where there is limited product demand and/or no opportunity for a mill using virgin fiber. Where the possibility of virgin pulp production exists, blended liner may provide a better return than kraft liner, particularly at the higher capacity. With a stable, low-cost source of OCC, blended liner becomes even more attractive, and jute liner becomes a competitive alternative.

TABLE IX-E-1

Economic Comparison of Linerboard Manufacture

Functional Group	Container Board			
Grade	Kraft Liner	Jute Liner	Blended Liner	Blended Liner
Basis Weight (g/m^2)	205 (42 lb/1000 sq ft)			
Fiber Furnish	100% Virgin	100% Secondary	80% Virgin 20% Secondary	
Plant Size (MT/day)	910	300	910	1140
Plant Location	Southeast	North Central	Southeast	Southeast
Plant Specifics	Integrated	Non-Integrated	Integrated	Integrated
Total Fixed Capital ($ Million)	110	30	106	119
($000/Daily Ton)	121	100	116	104
Total Delivered Cost ($/MDMT)	137.4	168.8	140.5	137.4
Raw Materials ($/MT, delivered)	47.4	75.9	51.3	51.2
Conversion ($/MT)	36.1	50.8	36.3	35.9
Capital-Related ($/MT)	26.9	23.1	25.9	23.3
Sales Cost (Less Freight) ($/MT)	7.0	7.0	7.0	7.0
Freight in ($/MT Product)*	14.1	11.5	13.1	13.1
Freight out ($/MT Product)	20.0	12.0	20.0	20.0
Selling Price ($/MDMT)	200	195	200	200
Return on Fixed Capital, pre-tax (%)	17.9	8.7	17.6	20.7

*Not included in total delivered cost

TABLE IX-E-2

DESIGN BASIS

Functional Group	Containerboard	Process	Kraft pulping/continuous digester
Grade	Unbleached kraft liner	Fiber Furnish	100% virgin fiber (80% softwood, 20% hardwood); 50/50 roundwood/chips
Basis Weight	205 g/m^2 (42 lb/1000 sq ft)	Pulp Yield	Unbleached – 52%
Production	910 MDMT/day; 314,000 MDMT/yr	Mill Location	Southeast
Net Operating Days	345/yr	Boundary Limits	Wood preparation through board making

CAPITAL REQUIREMENTS (\$000)

Physical Plant	100,000	
Other Fixed Capital	10,000	
Total Fixed Capital		110,000
Working Capital		11,000
Total Capital Required		121,000

ENERGY REQUIREMENTS (per MDMT)

	Steam (kg)	Power (kWh)
Wood Preparation	–	100
Pulping	1,600	105
Power & Steam Generation (incl. recovery and liquor prep.)	1,600	160
Effluent Treatment	–	30
Board Making	4,000	360
Misc. & Auxiliaries	800	95
Total	8,000	850

OPERATING COST* (\$/MDMT)

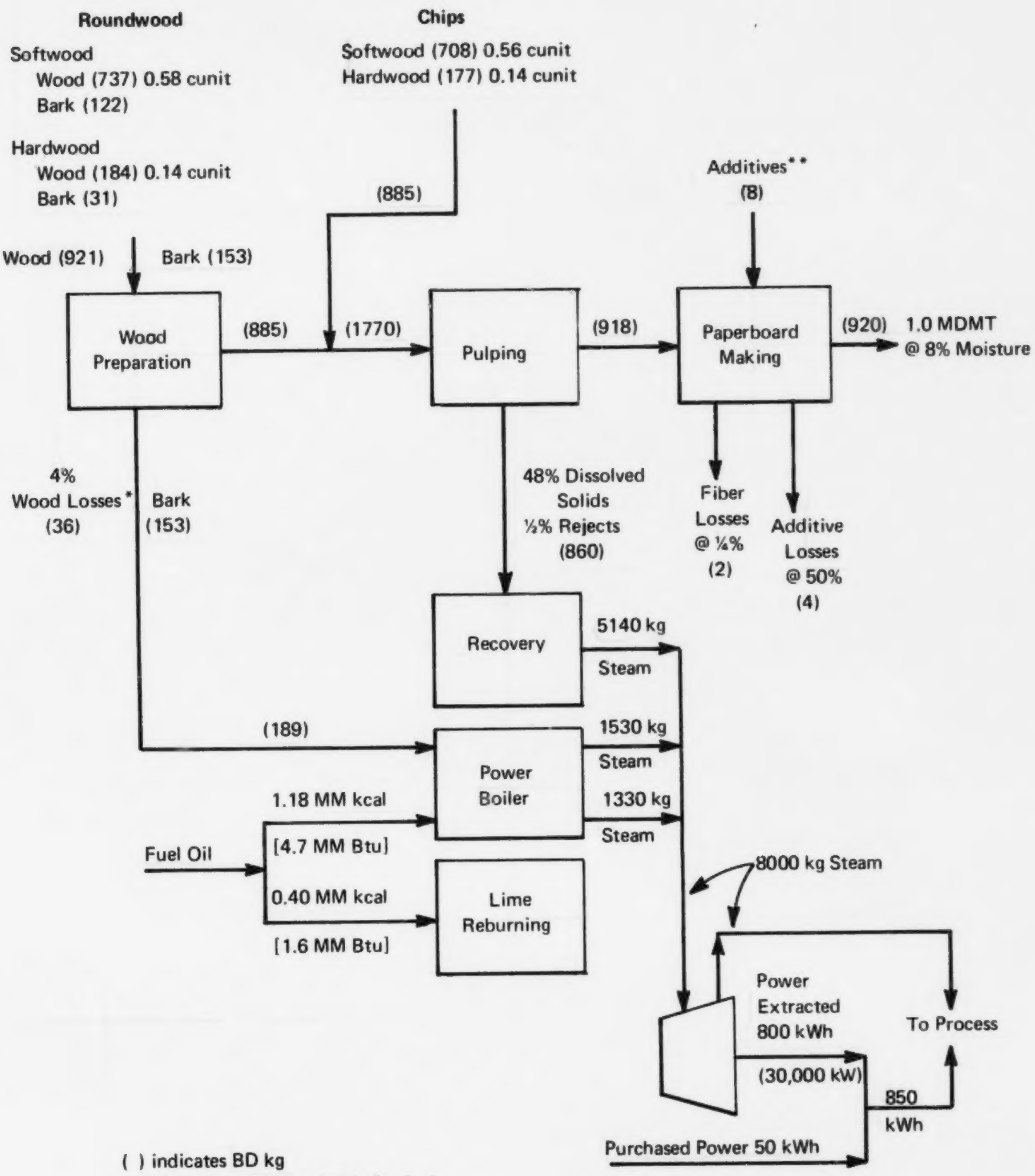
Fiber Furnish	43.8	
Other Raw Materials	3.6	
Total Raw Materials Cost		47.4
Labor + Fringe @ 32% of Hourly Rate	13.2	
Supplies	11.2	
Energy	6.9	
Factory Overhead	4.8	
Total Conversion Costs		36.1
Capital-Related Costs		26.9
• Total Factory Operating Cost		110.4 (\$100.2/ MDST)
GS&A	7.0	
Freight Out	20.0	
Total Cost of Sales		27.0
• Total Delivered Cost		137.4 (\$124.6/ MDST)

*Totals may not add due to rounding

FIG. IX-E-1

MATERIAL AND ENERGY BALANCE

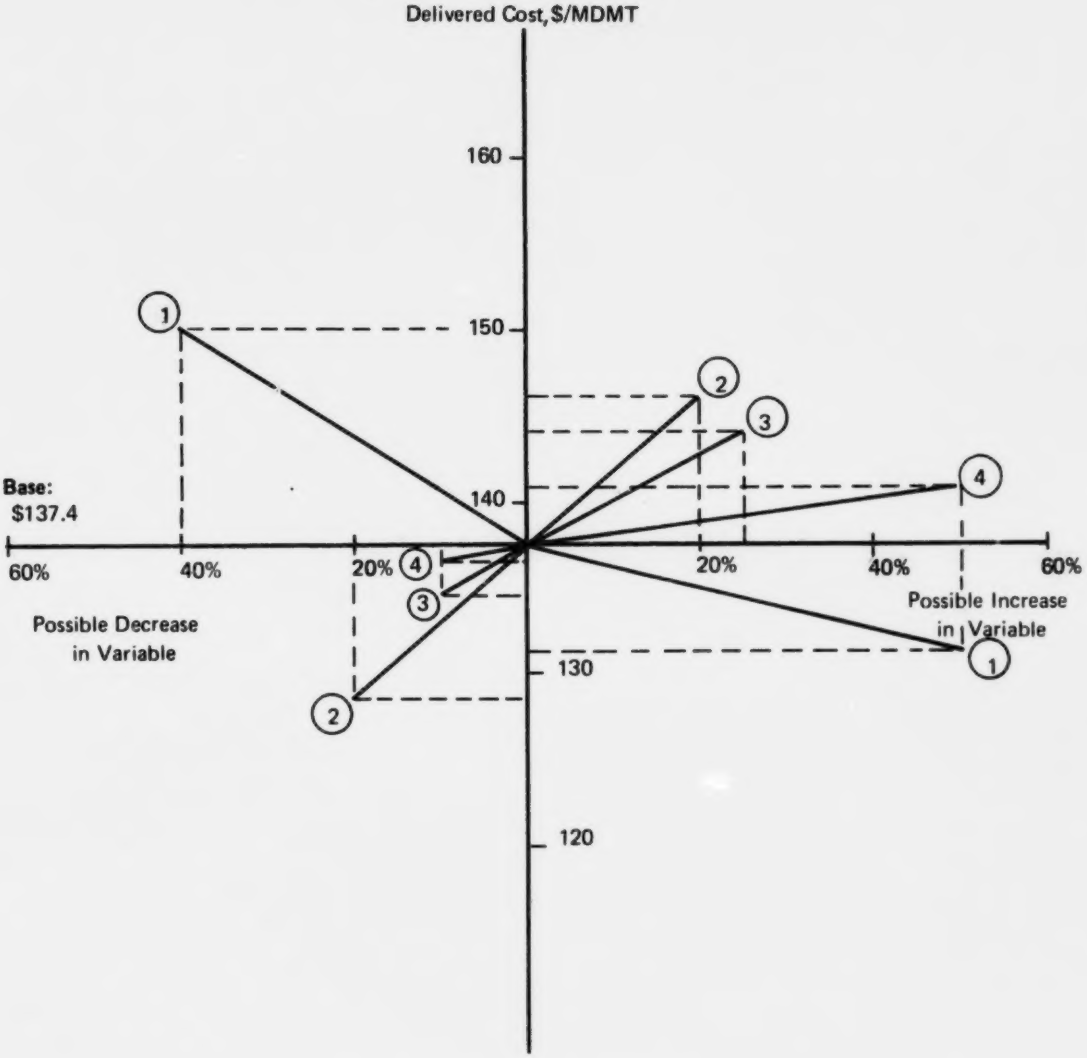
(**Basis:** 1 machine-dry metric ton of kraft liner)


Roundwood
Softwood
Wood (737) 0.58 cunit
Bark (122)
Hardwood
Wood (184) 0.14 cunit
Bark (31)
Chips
Softwood (708) 0.56 cunit
Hardwood (177) 0.14 cunit
(885)
Additives**
(8)
Wood (921)
Bark (153)
Wood Preparation
(885)
(1770)
Pulping
(918)
Paperboard Making
(920)
1.0 MDMT
@ 8% Moisture
4%
Wood Losses*
(36)
Bark
(153)
48% Dissolved Solids
½% Rejects
(860)
Fiber Losses @ ¼%
(2)
Additive Losses @ 50%
(4)
Recovery
5140 kg Steam
(189)
Power Boiler
1530 kg Steam
1330 kg Steam
1.18 MM kcal
[4.7 MM Btu]
Fuel Oil
0.40 MM kcal
[1.6 MM Btu]
Lime Reburning
8000 kg Steam
Power Extracted 800 kWh
(30,000 kW)
To Process
850 kWh
Purchased Power 50 kWh

( ) indicates BD kg

*2% loss on barking, suitable for fuel recovery, + 2% loss on chipping, suitable for fuel or fiber recovery

**Rosin 3 kg, alum 5 kg



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+50, –40	910	1370	545
2. Delivered Cost of Fiber,* $/Cunit	+20, –20	31	37	25
3. Fixed Capital, $ Million	+25, –10	110	138	99
4. Cost of Energy, $/MMBtu	+50, –10	1.0	1.5	0.9

*Average Pulpwood Cost

FIGURE IX–E–2 SENSITIVITY OF THE MANUFACTURING COST OF UNBLEACHED KRAFT LINER TO KEY VARIABLES

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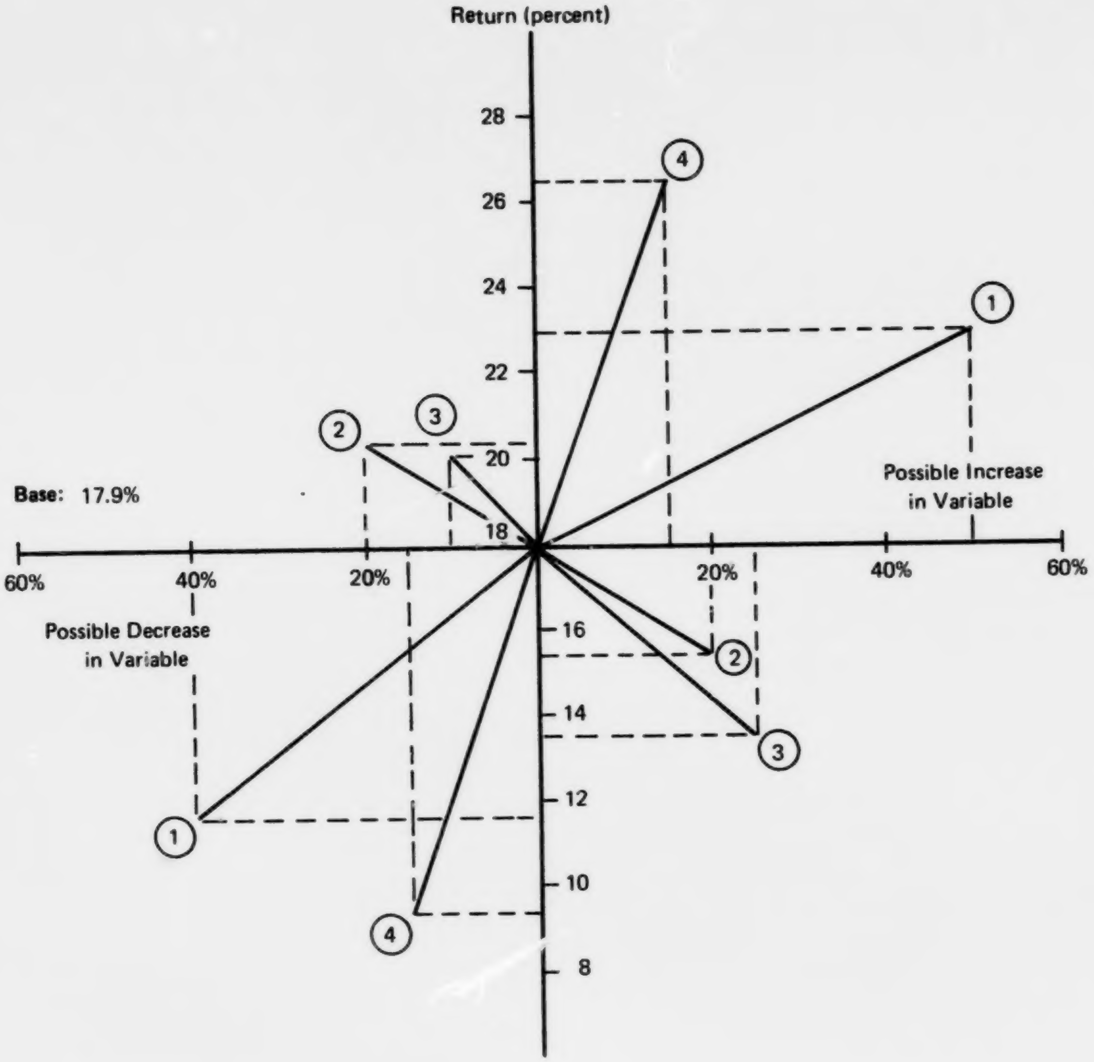


KEY VARIABLES		Percent Variation	Best Guess	Possible High	Possible Low
1.	Scale of Operations, MTPD	+50, −40	910	1370	545
2.	Delivered Cost of Fiber,* $/Cunit	+20, −20	31	37	25
3.	Fixed Capital, $ Million	+25, −10	110	138	99
4.	Selling Price, $/MDMT	+15, −15	200	230	170

*Average Pulpwood Cost

FIGURE IX–E–3 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF UNBLEACHED KRAFT LINER TO KEY VARIABLES

TABLE IX-E-4

DESIGN BASIS

Functional Group	Containerboard	Process	S/F pulping
Grade	Jute liner	Fiber Furnish	100% secondary fiber; OCC
Basis Weight	205 g/m^3 (42 lb/1000 sq ft)	Pulp Yield	n.a.
Production	300 MDMT/day; 100,000 MDMT/yr	Mill Location	North Central
Net Operating Days	330/yr	Boundary Limits	S/F preparation through board making

CAPITAL REQUIREMENTS* ($000)

Physical Plant	27,600	
Other Fixed Capital	2,800	
Total Fixed Capital		30,000
Working Capital		4,000
Total Capital Required		34,000

ENERGY REQUIREMENTS (per MDMT)

	Steam (kg)	Power (kWh)
A.D. S/F Plant	1,000	95
Pulping	–	230
Board Making	4,000	80
Effluent Treatment	–	30
Misc. & Auxiliaries	1,000	215
Total	6,000	650

*Totals may not add due to rounding.

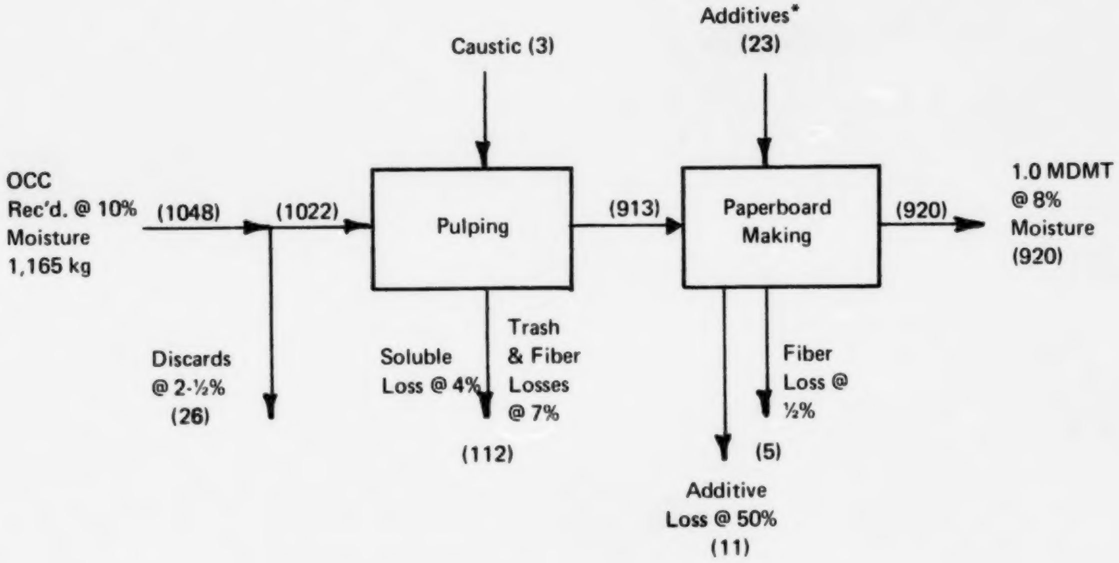
OPERATING COST ($/MDMT)

Fiber Furnish	63.3	
Other Raw Materials	12.6	
Total Raw Materials Cost		75.9
Labor + Fringe @ 32% of Hourly Rate	12.9	
Supplies	7.1	
Energy	24.3	
Factory Overhead	6.5	
Total Conversion Costs		50.8
Capital-Related Costs		23.1
• Total Factory Operating Cost		149.8 ($136.5/ MDST)
GS&A	7.0	
Freight Out	12.0	
Total Cost of Sales		19.0
• Total Delivered Cost		168.8 ($153.1/ MDST)

FIG. IX-E-4

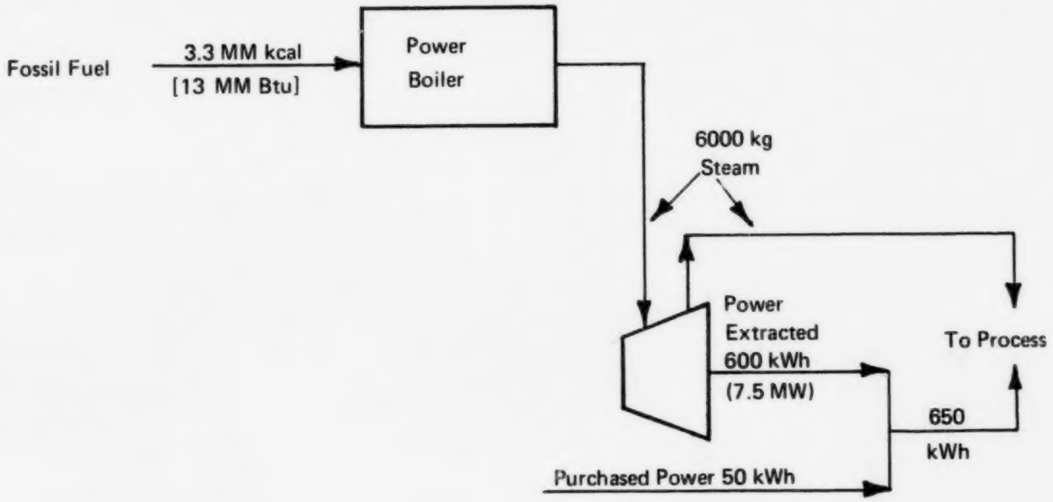
MATERIAL AND ENERGY BALANCE

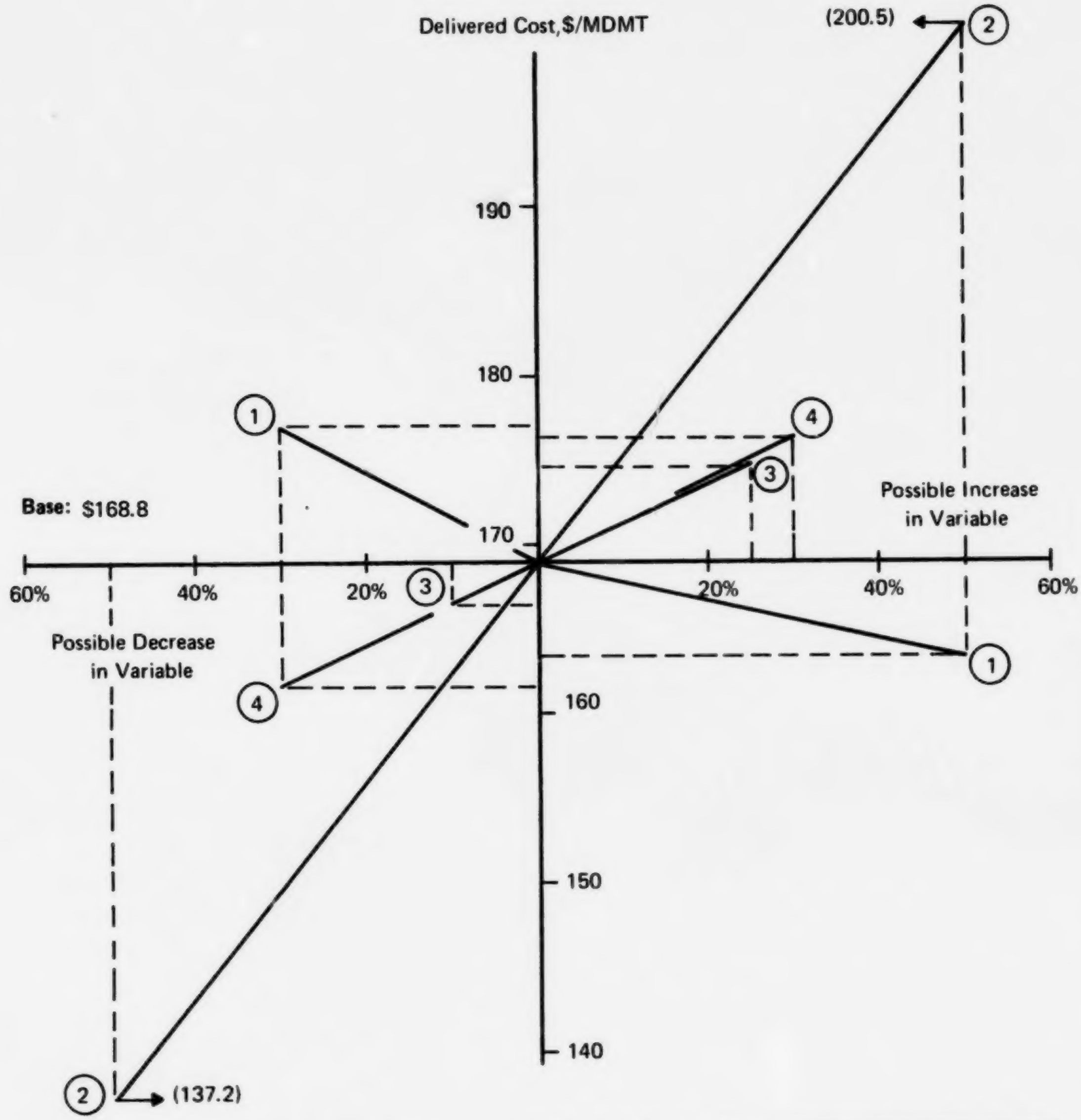
(Basis: 1 machine-dry metric ton of jute liner)


Caustic (3)
Additives*
(23)
OCC
Rec'd. @ 10%
Moisture
1,165 kg
(1048)
(1022)
Pulping
(913)
Paperboard
Making
(920)
1.0 MDMT
@ 8%
Moisture
(920)
Discards
@ 2-½%
(26)
Soluble
Loss @ 4%
Trash
& Fiber
Losses
@ 7%
(112)
Fiber
Loss @
½%
(5)
Additive
Loss @ 50%
(11)

( ) [illegible]icates BD kg

*Sta[illegible] 5 kg, rosin 3 kg, alum 5 kg


Fossil Fuel
3.3 MM kcal
[13 MM Btu]
Power
Boiler
6000 kg
Steam
Power
Extracted
600 kWh
(7.5 MW)
To Process
650
kWh
Purchased Power 50 kWh



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+50, −30	300	450	210
2. Delivered Cost of Fiber, $/ADMT	+50, −50	55	83	28
3. Fixed Capital, $ Million	+25, −10	30	38	27
4. Cost of Energy, $/MMBtu	+30, −30	1.8	2.3	1.3

FIGURE IX–E–5 SENSITIVITY OF THE MANUFACTURING COST OF JUTE LINER TO KEY VARIABLES

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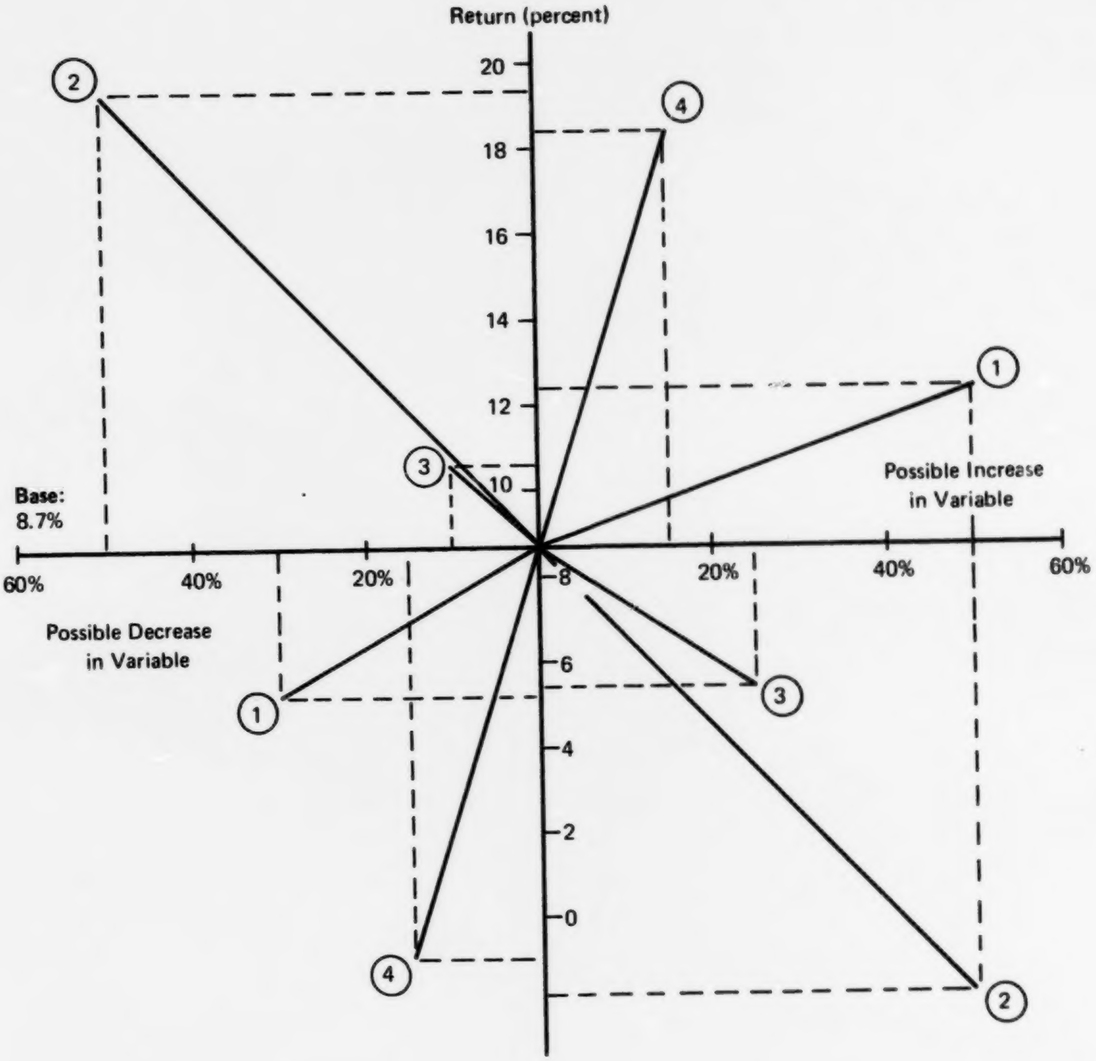


KEY VARIABLES		Percent Variation	Best Guess	Possible High	Possible Low
1.	Scale of Operations, MTPD	+50, −30	300	450	210
2.	Delivered Cost of Fiber, $/ADMT	+50, −50	55	83	28
3.	Fixed Capital, $ Million	+25, −10	30	38	27
4.	Selling Price, $/MDMT	+15, −15	195	224	166

FIGURE IX–E–6 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF JUTE LINER TO KEY VARIABLES

TABLE IX-E-6

DESIGN BASIS

Functional Group	Containerboard	Process	Kraft pulping/continuous digester
Grade	Blended linerboard	Fiber Furnish	80% virgin fiber, 20% S/F 50/50 roundwood/chips (64% SW, 16% HW) + 20% OCC
Basis Weight	205 g/m^2 (42 lb/1000 sq ft)	Pulp Yield	Unbleached – 52%
Production	910 MDMT/day; 314,000 MDMT/yr	Mill Location	Southeast
Net Operating Days	345/yr	Boundary Limits	Wood and S/F preparation through board making

CAPITAL REQUIREMENTS (\$000)

Physical Plant	96,700	
Other Fixed Capital	9,700	
Total Fixed Capital		106,000
Working Capital		11,000
Total Capital Required		117,000

ENERGY REQUIREMENTS (per MDMT)

	Steam (kg)	Power (kWh)
Wood Preparation	–	80
Pulping	1,300	84
Power & Steam Generation (incl. recovery & liquor preparation)	1,300	136
A.D. Secondary Fiber Plant	200	20
Stock Preparation	–	50
Paper Making	4,000	360
Effluent Treatment	–	30
Misc. & Auxiliaries	800	90
Total	7,600	850

OPERATING COST* (\$/MDMT)

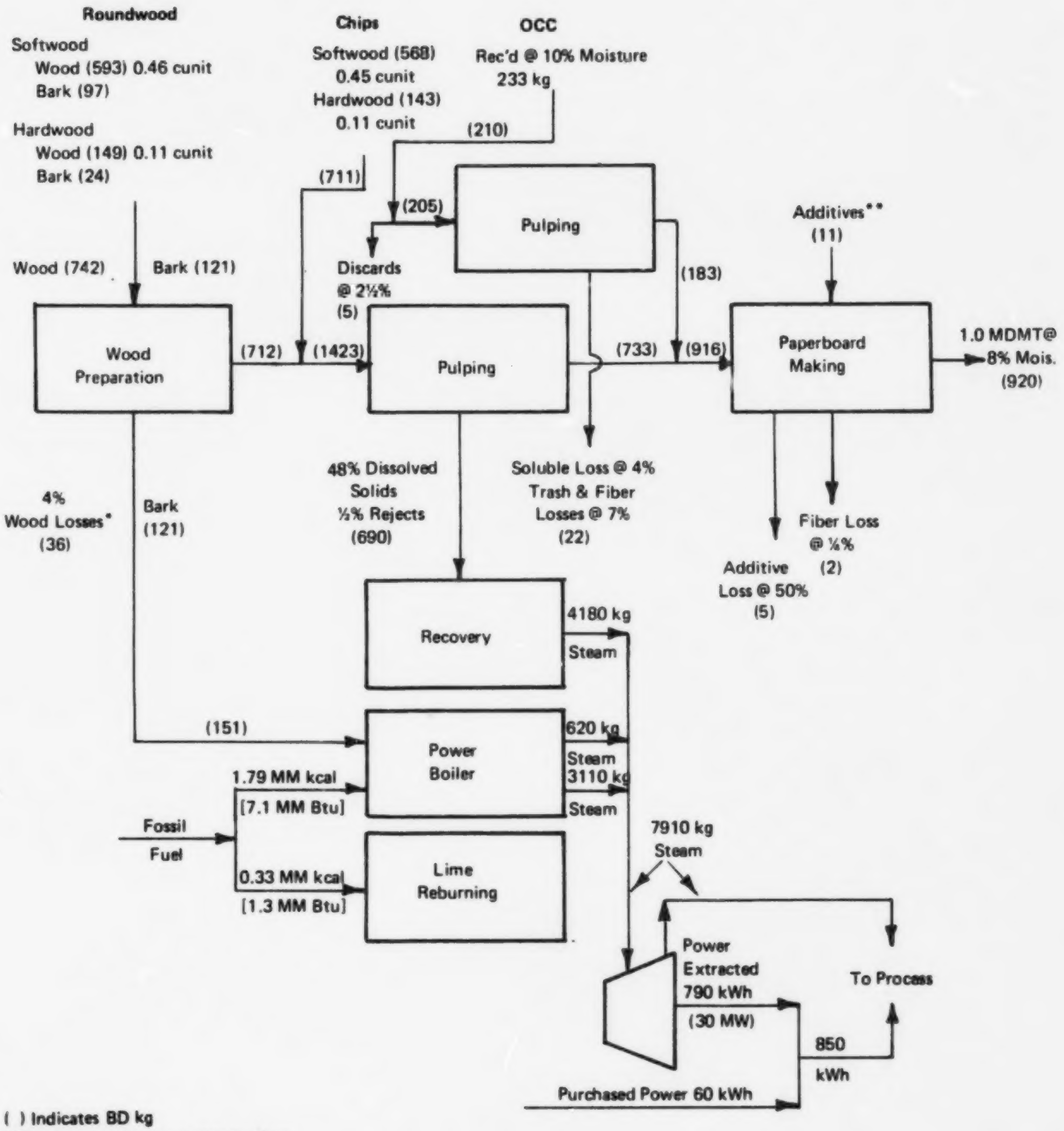
Fiber Furnish	47.9		
Other Raw Materials	3.3		
Total Raw Materials Cost		51.3	
Labor + Fringe @ 32% of Hourly Rate	13.2		
Supplies	9.4		
Energy	9.1		
Factory Overhead	4.8		
Total Conversion Costs		36.3	
Capital-Related Costs		25.9	
• Total Factory Operating Cost		113.5	(\$103.0/ MDST)
GS&A	7.0		
Freight Out	20.0		
Total Cost of Sales		27.0	
• Total Delivered Cost		140.5	(\$127.5/ MDST)

*Totals may not add due to rounding.

FIGURE IX-E-7

MATERIAL AND ENERGY BALANCE

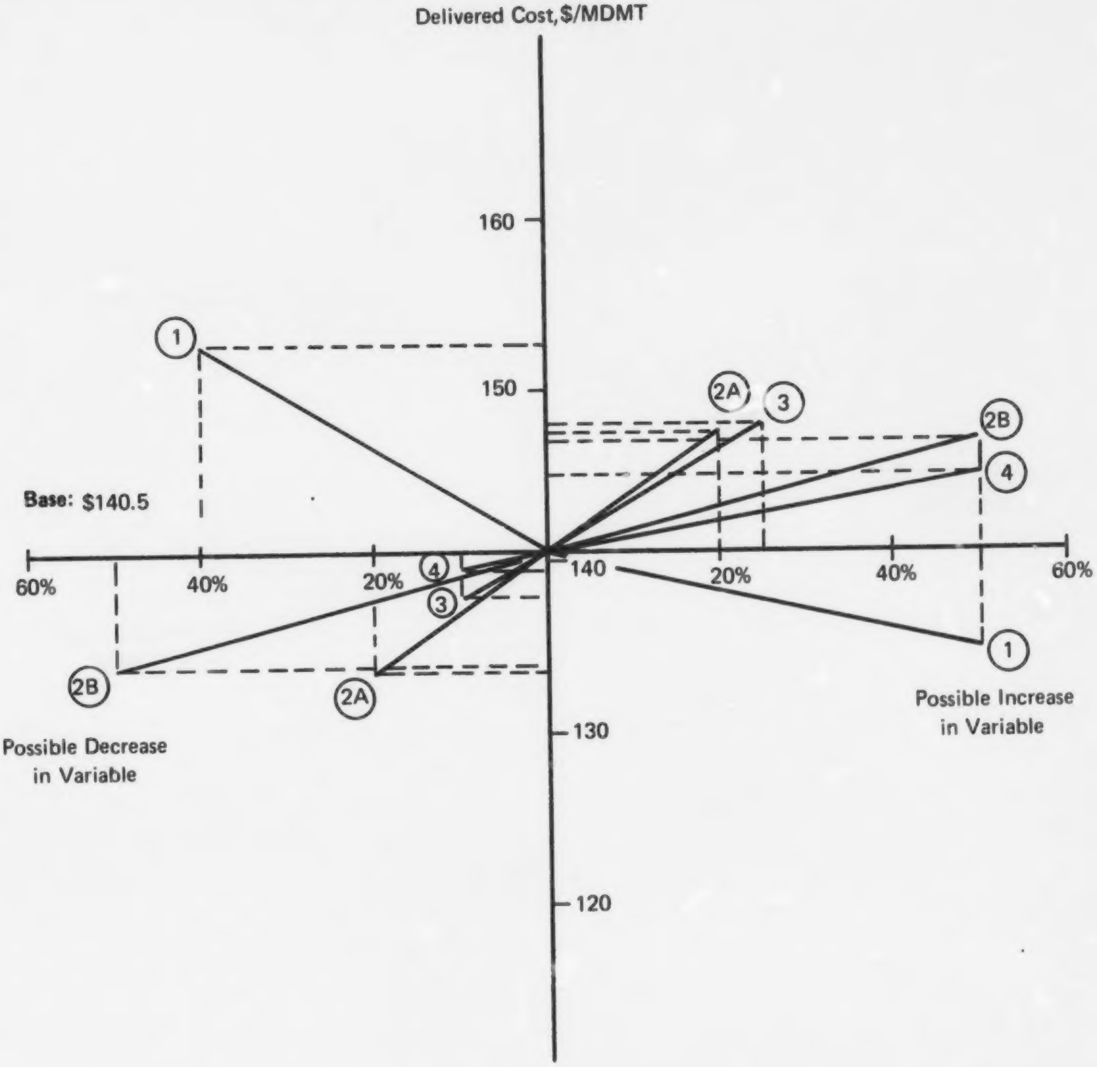
(Basis: 1 machine-dry metric ton of blended liner)


Roundwood
Softwood
Wood (593) 0.46 cunit
Bark (97)
Hardwood
Wood (149) 0.11 cunit
Bark (24)
Chips
Softwood (568)
0.45 cunit
Hardwood (143)
0.11 cunit
OCC
Rec'd @ 10% Moisture
233 kg
(210)
(711)
(205)
Pulping
Discards
@ 2½%
(5)
Additives**
(11)
(183)
Wood (742)
Bark (121)
Wood
Preparation
(712)
(1423)
Pulping
(733)
(916)
Paperboard
Making
1.0 MDMT@
8% Mois.
(920)
4%
Wood Losses*
(36)
Bark
(121)
48% Dissolved
Solids
½% Rejects
(690)
Soluble Loss @ 4%
Trash & Fiber
Losses @ 7%
(22)
Fiber Loss
@ ¼%
(2)
Additive
Loss @ 50%
(5)
Recovery
4180 kg
Steam
(151)
Power
Boiler
620 kg
Steam
3110 kg
Steam
1.79 MM kcal
[7.1 MM Btu]
Fossil
Fuel
0.33 MM kcal
[1.3 MM Btu]
Lime
Reburning
7910 kg
Steam
Power
Extracted
790 kWh
(30 MW)
To Process
850
kWh
Purchased Power 60 kWh

( ) Indicates BD kg

*2% loss on barking, suitable for fuel recovery, + 2% loss on chipping, suitable for fuel or fiber recovery.

**Starch 3 kg, rosin 3 kg, alum 5 kg



KEY VARIABLES		Percent Variation	Best Guess	Possible High	Possible Low
1.	Scale of Operations, MTPD	+50, −40	910	1365	545
2. A B	Delivered Cost of Fiber,* $/Cunit ADMT	+20, −20 +50, −50	31 60	37 90	25 30
3.	Fixed Capital, $ Million	+25, −10	106	133	95
4.	Cost of Energy, $/MMBtu	+50, −10	1.0	1.5	0.9

*2A—Virgin, 2B—Secondary Fiber

FIGURE IX–E–8 SENSITIVITY OF THE MANUFACTURING COST OF BLENDED LINER (CASE I) TO KEY VARIABLES

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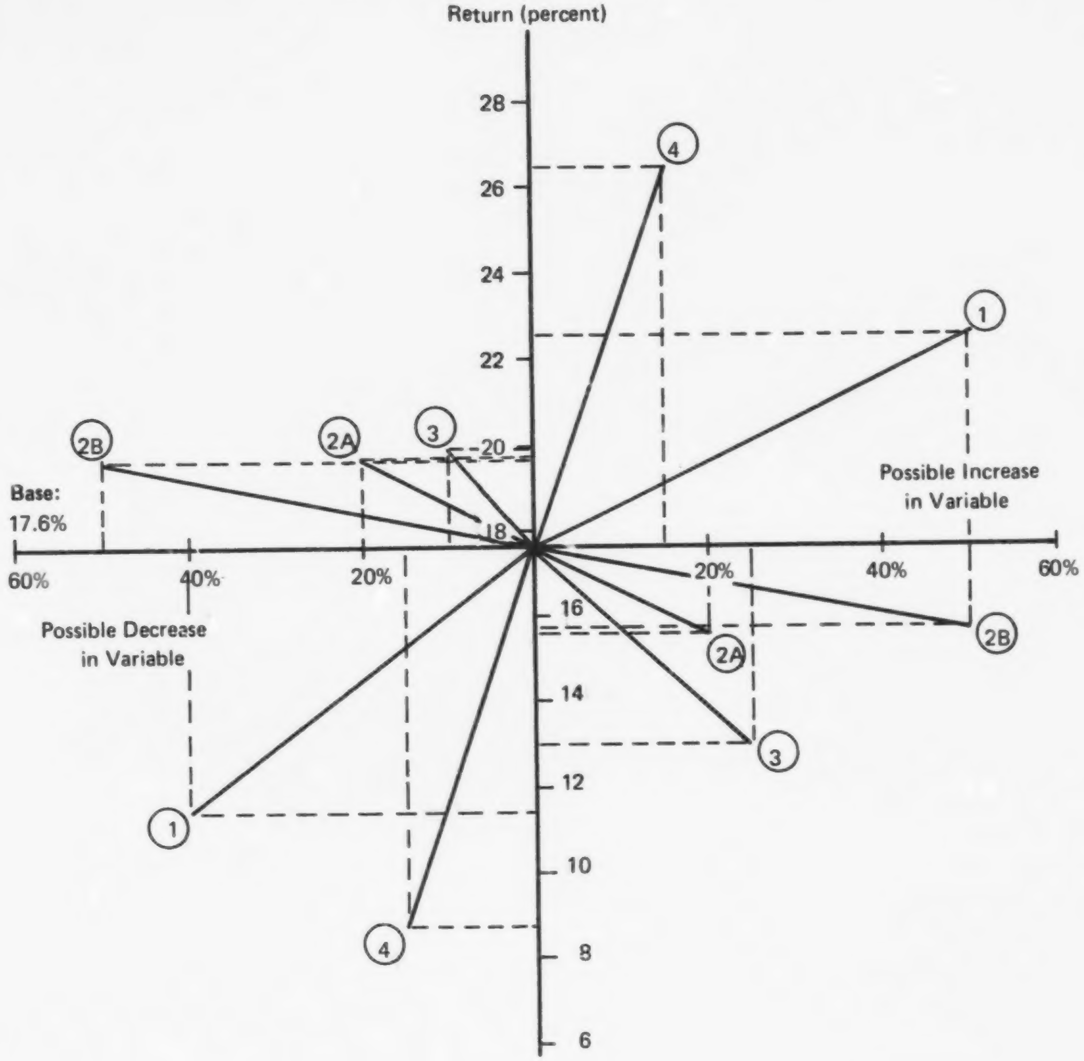


KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+50, –40	910	1370	545
2. A Delivered Fiber Cost,* /Cunit	+20, –20	31	37	25
B Delivered Fiber Cost,* $/ADMT	+50, –50	60	90	30
3. Fixed Capital, $ Million	+25, –10	106	133	95
4. Selling Price, $/MDMT	+15, –15	200	230	170

*2A–Virgin, 2B–Secondary Fiber

FIGURE IX–E–9 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF BLENDED LINER (CASE I) TO KEY VARIABLES

TABLE IX-E-8

DESIGN BASIS

Functional Group	Containerboard	Process	Kraft pulping/continuous digester
Grade	Blended linerboard	Fiber Furnish	80% virgin fiber, 20% S/F 50/50 roundwood/chips (64% SW, 16% HW) +20% OCC
Basis Weight	205 g/m^2 (42 lb/1000 sq ft)	Pulp Yield	Unbleached – 52%
Production	1140 MDMT/day; 393,000 MDMT/yr	Mill Location	Southeast
Net Operating Days	345/yr	Boundary Limits	Wood and S/F preparation through board making

CAPITAL REQUIREMENTS* ($000)

Physical Plant	108,500	
Other Fixed Capital	10,900	
Total Fixed Capital		119,000
Working Capital		13,000
Total Capital Required		132,000

ENERGY REQUIREMENTS (per MDMT)

	Steam (kg)	Power (kWh)
Wood Preparation	–	80
Pulping	1,300	80
Power & Steam Generation (incl. recovery and liquor prep.)	1,300	140
A.D. Secondary Fiber Plant	200	20
Stock Preparation	–	50
Board Making	4,000	360
Effluent Treatment	–	30
Misc. & Auxiliaries	800	90
Total	7,600	850

OPERATING COST* ($/MDMT)

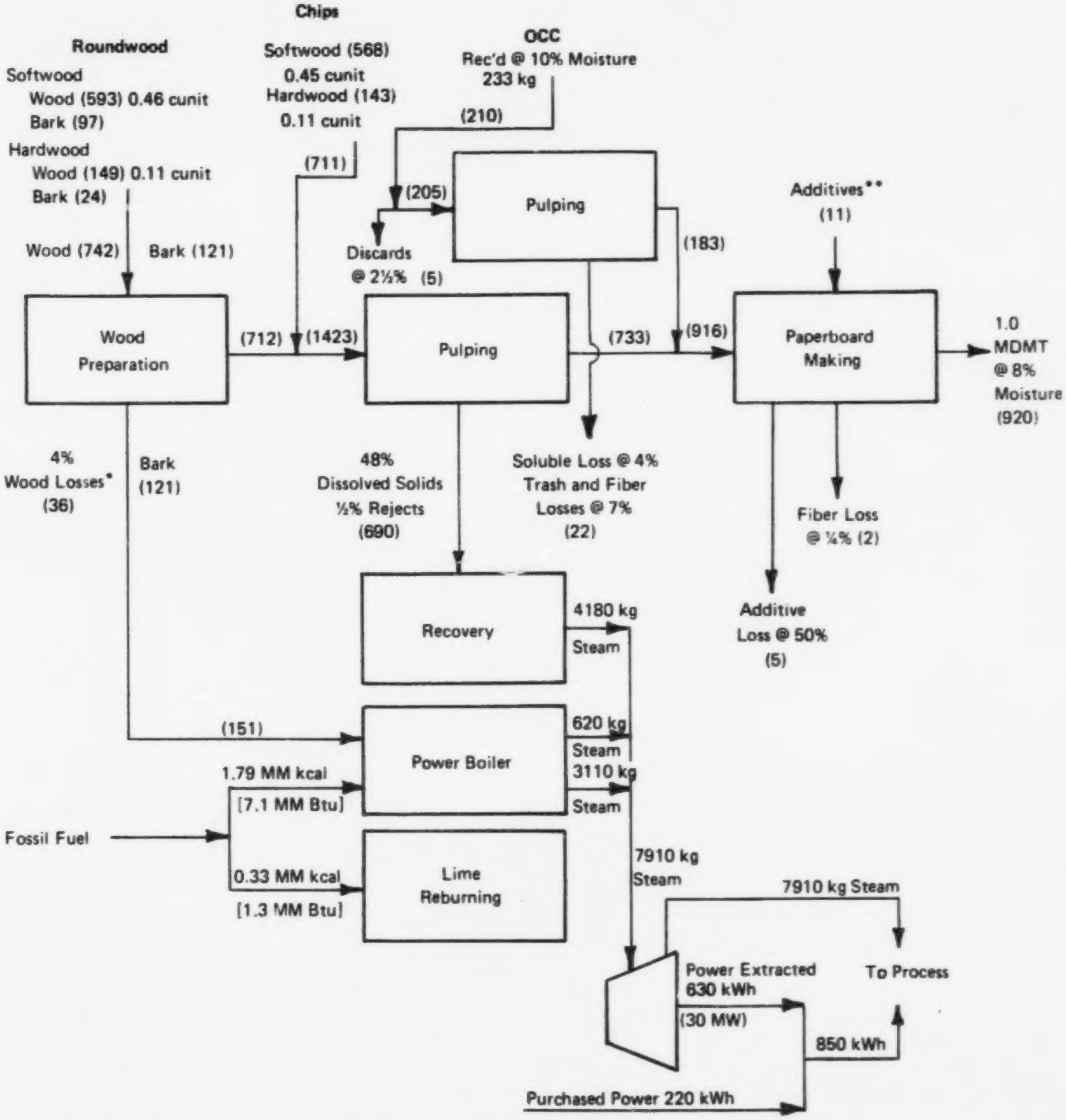
Fiber Furnish	47.9	
Other Raw Materials	3.3	
Total Raw Materials Cost		51.2
Labor + Fringe @ 32% of Hourly Rate	11.8	
Supplies	9.1	
Energy	11.0	
Factory Overhead	4.3	
Total Conversion Costs		35.9
Capital-Related Costs		23.3
• Total Factory Operating Cost		110.4 ($100.2/MDST)
GS&A	7.0	
Freight Out	20.0	
Total Cost of Sales		27.0
• Total Delivered Cost		137.4 ($124.6/MDST)

*Totals may not add due to rounding.

FIGURE IX-E-10

MATERIAL AND ENERGY BALANCE

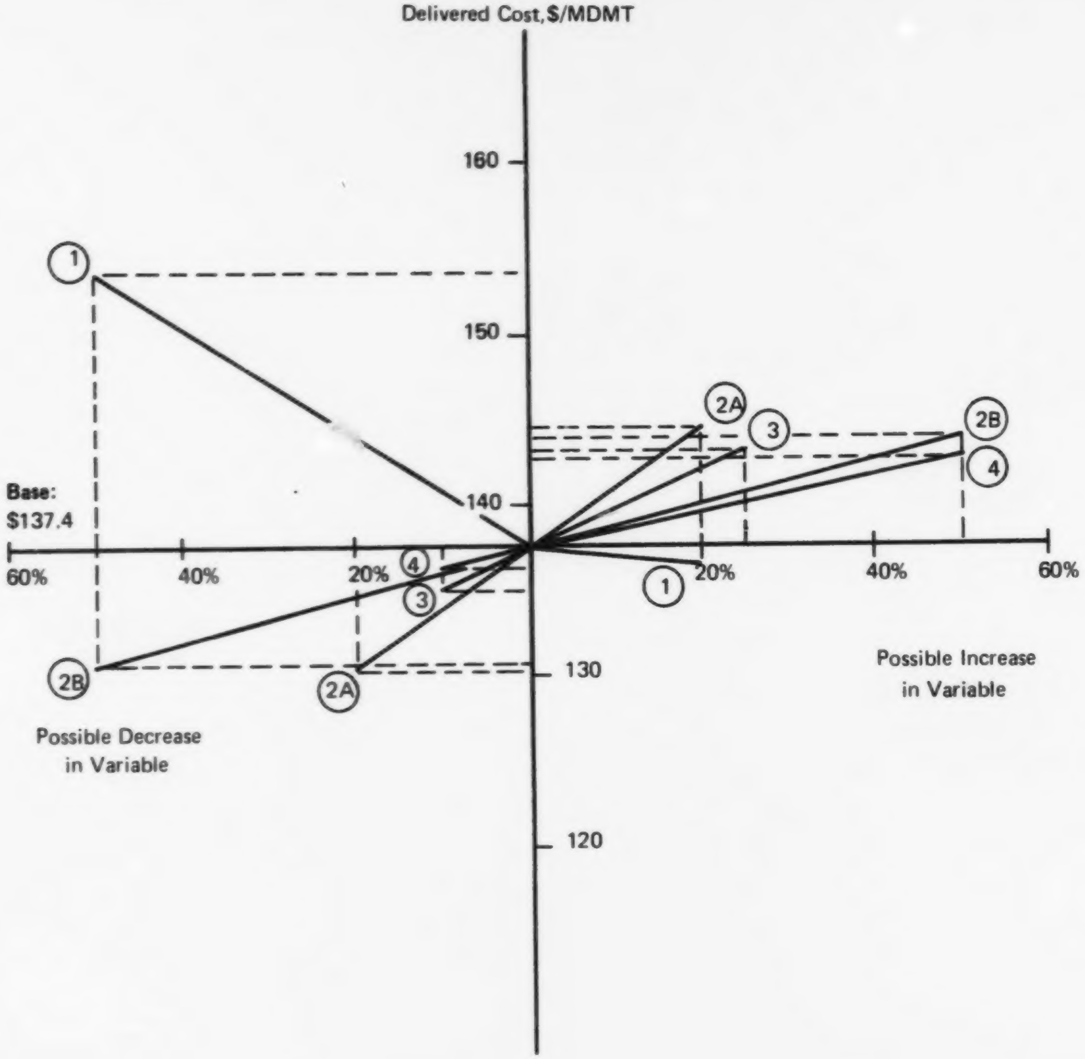
(Basis: 1 machine-dry metric ton of blended liner)


Roundwood
Softwood
Wood (593) 0.46 cunit
Bark (97)
Hardwood
Wood (149) 0.11 cunit
Bark (24)
Wood (742)
Bark (121)
Chips
Softwood (568)
0.45 cunit
Hardwood (143)
0.11 cunit
(711)
OCC
Rec'd @ 10% Moisture
233 kg
(210)
(205)
Pulping
Discards
@ 2½% (5)
(183)
Additives**
(11)
Wood
Preparation
(712)
(1423)
Pulping
(733)
(916)
Paperboard
Making
1.0
MDMT
@ 8%
Moisture
(920)
4%
Wood Losses*
(36)
Bark
(121)
48%
Dissolved Solids
½% Rejects
(690)
Soluble Loss @ 4%
Trash and Fiber
Losses @ 7%
(22)
Fiber Loss
@ ¼% (2)
Additive
Loss @ 50%
(5)
Recovery
4180 kg
Steam
(151)
Power Boiler
620 kg
Steam
3110 kg
Steam
1.79 MM kcal
[7.1 MM Btu]
Fossil Fuel
0.33 MM kcal
[1.3 MM Btu]
Lime
Reburning
7910 kg
Steam
7910 kg Steam
To Process
Power Extracted
630 kWh
(30 MW)
850 kWh
Purchased Power 220 kWh

( ) Indicated BD kg

* 2% loss on barking, suitable for fuel recovery, + 2% loss on chipping, suitable for fuel or fiber recovery

** Fiber loss (suitable for recovery in lower-grade products)



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+20, −50	1140	1365	570
2. A Delivered Fiber Cost,* $/Cunit	+20, −20	31	37	25
B Delivered Fiber Cost,* $/ADMT	+50, −50	60	90	30
3. Fixed Capital, $ Million	+25, −10	119	149	107
4. Cost of Energy, $/MMBtu	+50, −10	1.0	1.5	0.9

*2A–Virgin, 2B–Secondary Fiber

FIGURE IX–E–11 SENSITIVITY OF THE MANUFACTURING COST OF BLENDED LINER (CASE II) TO KEY VARIABLES

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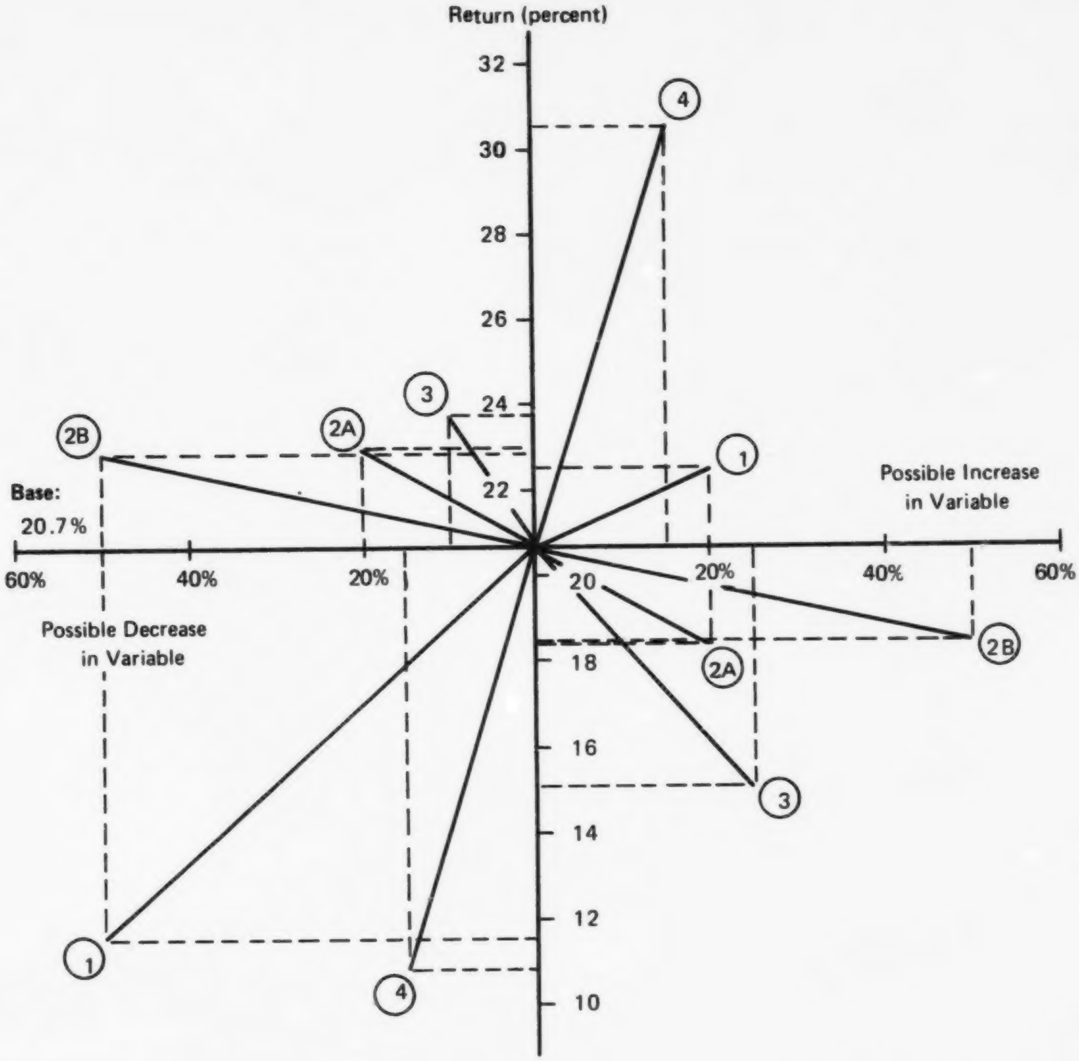


KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+20, −50	1140	1370	570
2. A Delivered Fiber Cost,* /Cunit	+20, −20	31	37	25
B $/ADMT	+50, −50	60	90	30
3. Fixed Capital, $ Million	+25, −10	119	149	107
4. Selling Price, $/MDMT	+15, −15	200	230	170

*2A–Virgin, 2B–Secondary Fiber

FIGURE IX–E–12 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF BLENDED LINER (CASE II) TO KEY VARIABLES

E. CONTAINERBOARD (cont'd)

2. Corrugating Medium

a. Basis of Models

Three economic models have been prepared for the production of corrugating medium from virgin, secondary fiber, and a blend of both. As the products from these models serve competitive markets, they must be of approximately equivalent quality.

In the manufacture of semi-chemical corrugating medium, 15-20% softwood kraft long fiber is generally added to the virgin NSSC hardwood furnish to provide strength in the papermaking operation. We used 15% new double lined kraft clippings as a source of softwood kraft fiber, which is typical of industry practice.

Although some mixed waste and/or waste news reportedly can be used im the fiber furnish of bogus medium with no loss of product quality, we used 100% OCC for this cost model.

A combination of 33% OCC, 15% new double lined kraft clippings, and 52% NSSC pulp was used in the blended fiber model. Obviously, the ultimate selection of fiber blend is influenced by the competitive costs of the alternative raw materials at any specific mill site.

Despite the fact that there is little significant difference in quality among these products, the marketplace tends to distinguish bogus medium and discount it approximately $5/ton. We have accounted for this difference in our selling price estimate and return on capital calculations, although it would not be likely to hold up under conditions of tight supply. The effect on return on capital by eliminating this price difference can be determined from the sensitivity chart for bogus medium.

NSSC corrugating medium is produced in all geographic regions. We have chosen a Southeast location for the virgin and blended models as typical of the existing industry and consistent with the frequent combination of linerboard and corrugating medium with cross-recovery of pulping liquors. Regional variations can be evaluated through use of the regional data previously presented (Table IX-C-1), in combination with the sensitivity charts for each model.

The virgin and blended corrugating medium models are sized at 410 ADMT/day to reflect a competitive scale of operations for a new mill. This is typical of the largest existing installations, but not the largest corrugating medium machine that is technically feasible. The 410-tpd capacity for the semichemical medium production is also consistent with NSSC/kraft spent-liquor ratios suitable for cross-recovery of the pulping liquor in typical combination medium and linerboard mills. Since the blended fiber model represents a total new mill installation, it is only qualitatively indicative of the economics or the possible advantages of adding secondary fiber capacity in a situation where machine capacity might be economically expanded even if pulping capacity were limited. (We have not attempted to determine how many machines have the potential for capacity expansion.) We have not idled pulp mill capacity for replacement with secondary fiber in the blended model, and it in no way indicates the economics of such an operation.

Bogus medium production is centered in metropolitan areas, with some concentration in the North Central region. We have used this region for our typical model; the economics of other regions can be determined through the use of regional data and sensitivity charts. We have selected mill capacity at 300 ADMT/day, based on the existing industry characteristics and on our judgment of the availability of fiber at competitive cost to supply a mill; however, it is not technically limited to this capacity.

b. Comparative Economics

Total fixed capital for the NSSC and blended models includes wood preparation, pulping, and medium production, with on-site power generation. A wide variety of process conditions are possible for NSSC pulping. We have selected a sodium-based process with purchases sulfite and soda ash chemical makeup. A fluidized bed disposal burner with byproduct credit for saltcake is used; however, the potential for cross-recovery of pulping chemicals in combination with kraft lin er production also exists. Total capital for bogus medium production is based on a single machine and does not include on-site power generation, as the total steam requirements are below the minimum we have established for on-site power (see Section C.2.d). It does not include an asphalt dispersion system for OCC pulping, as this is not required to meet product quality requirements.

The total capital requirements for bogus medium are considerably lower than for either the NSSC or blended models, both in total magnitude and investment per daily ton. In terms of return on capital, this tends to offset the higher operating cost and lower selling price for bogus medium; thus, all three models have comparable returns.

The delivered cost disadvantage of bogus medium is its raw material cost rather than its lower scale of operations. This difference is totally due to cost of fiber and could be completely eliminated within the highly volatile range of OCC cost, as demonstrated on the sensitivity chart. Because of the lower capital requirements for bogus medium, its return on investment is even more sensitive than delivered cost, relative to the other models, to decreases in OCC cost.

While the basic models are approximately comparable in return on capital, with NSSC pulping the most attractive, the relationship changes dramatically as the cost of secondary fiber drops. Bogus medium would be the most attractive alternative with a stable, low-cost source of OCC, even with the disadvantage of a selling price discount not based on product quality; if the selling price discount were eliminated by market conditions, it obviously would be even more attractive. Depending on the cost of OCC, either NSSC corrugating medium or bogus medium would show a higher return than the blended model. Thus, blended medium would probably be an attractive alternative only in special situations.

TABLE IX-E-10

ECONOMIC COMPARISON OF CORRUGATING MEDIUM

Functional Group	Containerboard		
Grade	Corrugating Medium		
Basis Weight (g/m^2)	127 (26 lb/1000 sq ft)		
Fiber Furnish	85% Virgin 15% S/F	100% S/F	57% Virgin 43% S/F
Plant Size (MT/Day)	410	300	410
Plant Location	Southeast	No. Central	Southeast
Plant Specifics	Integrated	Nonintegrated	Integrated
Total Fixed Capital ($Million)	45	24	44
($000 Daily Ton)	110	80	107
Total Delivered Cost ($/MDMT)	146.4	156.6	148.2
Raw Materials ($/MT, delivered)	48.9	68.4	55.2
Conversion ($/MT)	52.1	50.7	50.4
Capital-Related ($/MT)	24.5	18.5	23.9
Sales Cost (less freight) ($/MT)	7.0	7.0	7.0
Freight in ($/MT Product)*	9.5	11.8	10.1
Freight out ($/MT Product)	14.0	12.0	14.0
Selling Price ($/MDMT)	190	185	190
Return on Fixed Capital, pre-tax (%)	13.7	11.8	12.7

*Not included in total delivered cost

TABLE IX-E-11

DESIGN BASIS

Functional Group	Containerboard	Process	NSSC pulping, Na base
Grade	NSSC Corrugating Medium	Fiber Furnish	85% virgin, 15% S/F (kraft chippings)
Basis Weight	127 g/m^2 (26 lb/1000 sq ft)	Pulp Yield	Unbleached – 75%
Production	410 MDMT/day; 141,000 MDMT/yr	Mill Location	Southeast
Net Operating Days	345/yr	Boundary Limits	Wood and S/F preparation through paperboard making

CAPITAL REQUIREMENTS* (\$000)

Physical Plant	41,000	
Other Fixed Capital	4,100	
Total Fixed Capital		45,000
Working Capital		5,000
Total Capital Required		50,000

ENERGY REQUIREMENTS (per MDMT)

	Steam (kg)	Power (kWh)
Wood Preparation	–	100
Pulping	1,000	150
Power & Steam Gen. (incl. recovery & liquor prep.)	1,600	160
Stock Preparation	–	150
Effluent Treatment	–	30
Board Making	4,000	100
Misc. & Auxiliaries	400	110
Total	7,000	800

OPERATING COST* (\$/MDMT)

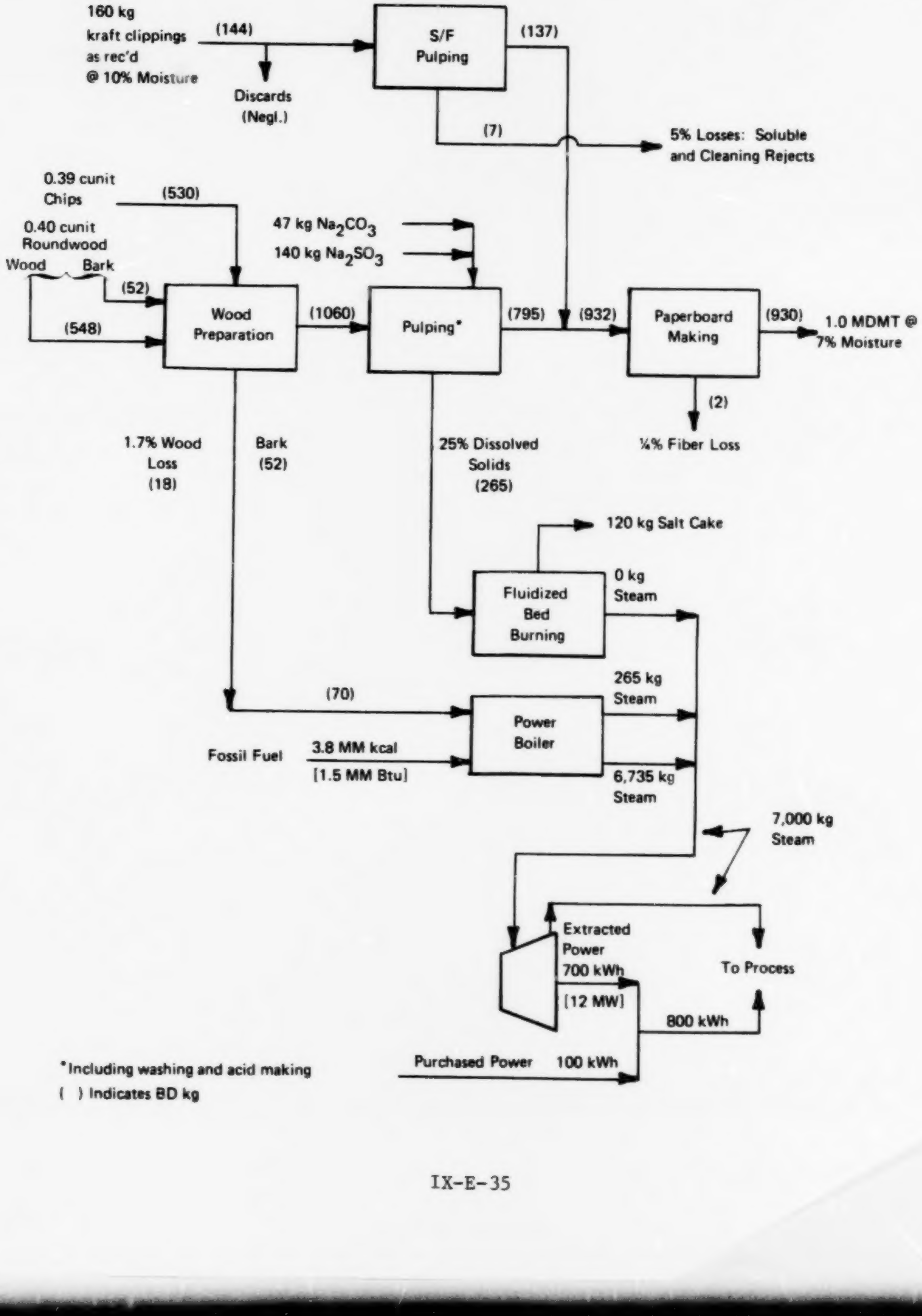
Fiber Furnish	34.9	
Other Raw Materials	14.0	
Total Raw Materials Cost		48.9
Labor + Fringe @ 32% of Hourly Rate	19.3	
Supplies	8.5	
Energy	16.2	
Factory Overhead	8.2	
Total Conversion Costs		52.1
Capital-Related Costs		24.5
● Total Factory Operating Cost		125.4 (\$113.7/MDST)
GS&A	7.0	
Freight Out	14.0	
Total Cost of Sales		21.0
● Total Delivered Cost		146.4 (\$132.8/MDST)

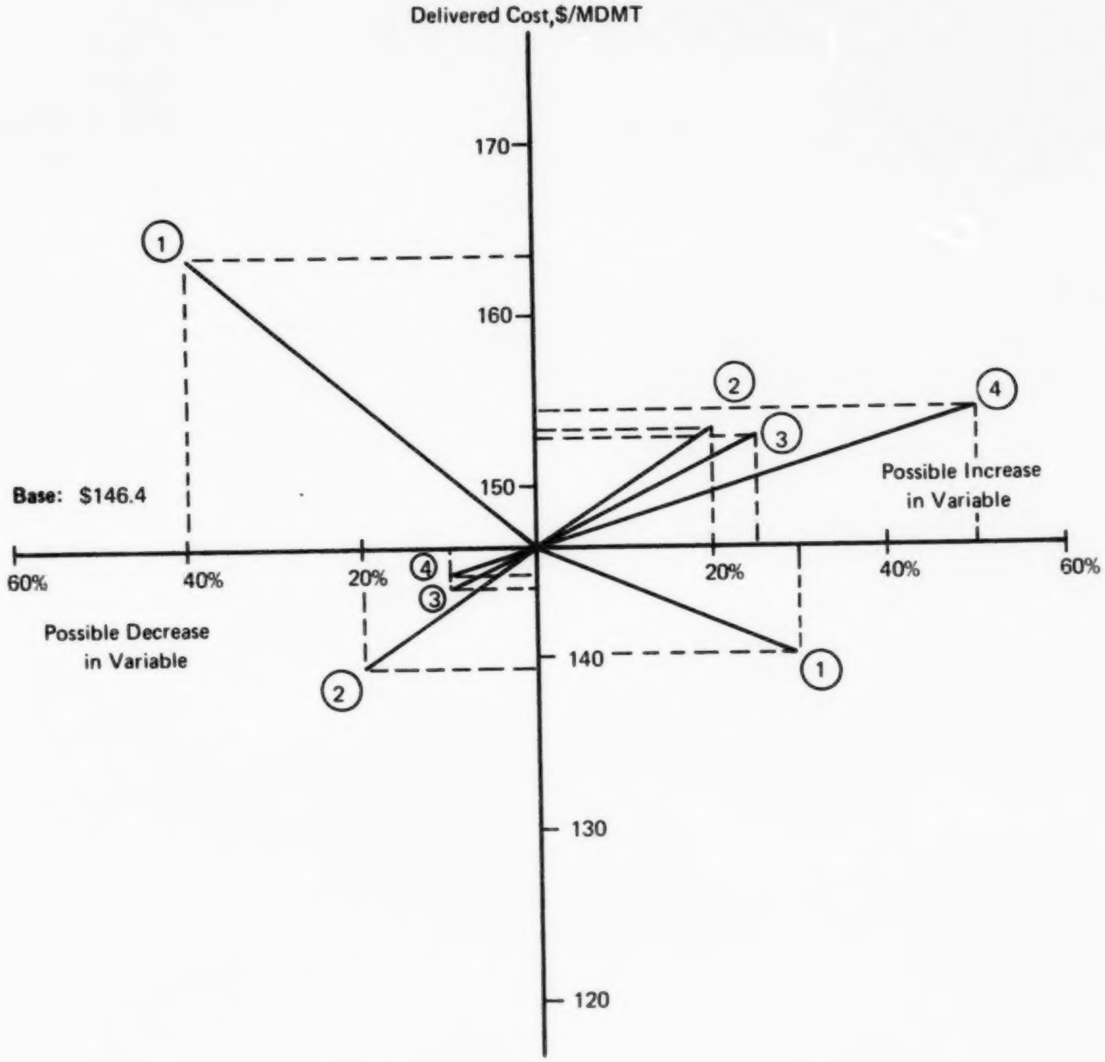
*Totals may not add due to rounding.

FIGURE IX-E-13

MATERIAL AND ENERGY BALANCE

(Basis: 1.0 MDMT corrugating medium)


160 kg
kraft clippings
as rec'd
@ 10% Moisture
(144)
Discards
(Negl.)
S/F
Pulping
(137)
(7)
5% Losses: Soluble
and Cleaning Rejects
0.39 cunit
Chips
(530)
0.40 cunit
Roundwood
Wood
Bark
(52)
(548)
47 kg Na_2CO_3
140 kg Na_2SO_3
Wood
Preparation
(1060)
Pulping*
(795)
(932)
Paperboard
Making
(930)
1.0 MDMT @
7% Moisture
(2)
¼% Fiber Loss
1.7% Wood
Loss
(18)
Bark
(52)
25% Dissolved
Solids
(265)
120 kg Salt Cake
0 kg
Steam
Fluidized
Bed
Burning
(70)
Power
Boiler
265 kg
Steam
Fossil Fuel
3.8 MM kcal
[1.5 MM Btu]
6,735 kg
Steam
7,000 kg
Steam
Extracted
Power
700 kWh
[12 MW]
To Process
800 kWh
Purchased Power
100 kWh
*Including washing and acid making
( ) Indicates BD kg



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+30, −40	410	530	245
2. A Delivered Cost of Fiber,* $/Cunit	+20, −20	30	36	24
B $/ADMT		70	84	56
3. Fixed Capital, $ Million	+25, −10	45	56	41
4. Cost of Energy, $/MMBtu	+50, −10	1.0	1.5	0.9

*Graph Shows Percentage Change in Combined Total Fiber Cost
2A—Virgin, 2B—Kraft Clippings

FIGURE IX–E–14 SENSITIVITY OF THE MANUFACTURING COST OF NSSC CORRUGATING MEDIUM TO KEY VARIABLES

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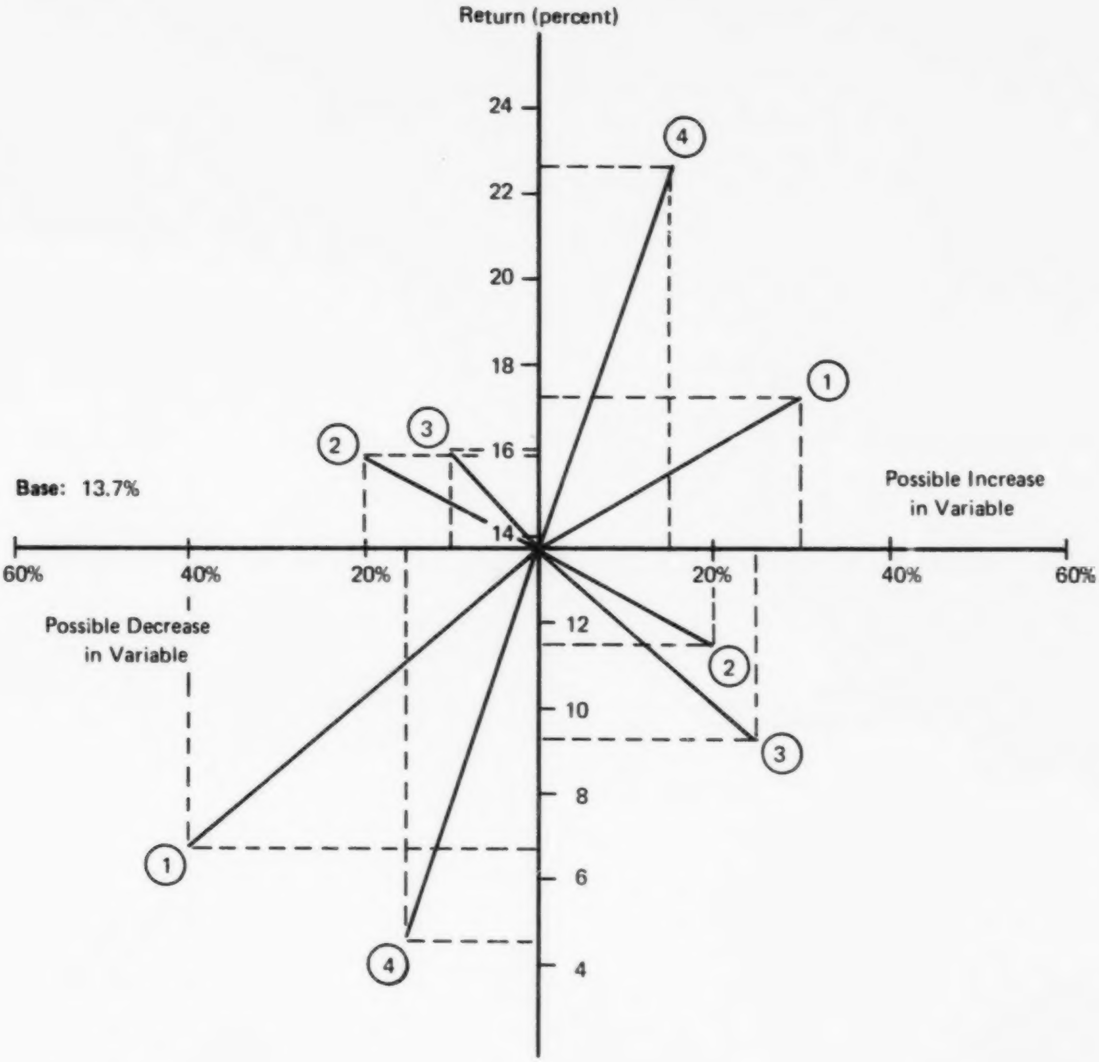


KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+30, −40	410	530	245
2. A B Delivered Cost of Fiber,* $/Cunit ADMT	+20, −20	30 70	36 84	24 56
3. Fixed Capital, $ Million	+25, −10	45	56	41
4. Selling Price, $/MDMT	+15, −15	190	219	161

*Graph Shows Percentage Change in Combined Total Fiber Cost
2A—Virgin, 2B—Secondary

FIGURE IX-E-15 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF NSSC CORRUGATING MEDIUM TO KEY VARIABLES

TABLE IX-E-13

DESIGN BASIS

Functional Group	Containerboard	Process	S/F pulping
Grade	Corrugating (bogus) Medium	Fiber Furnish	100% Secondary fiber (OCC)
Basis Weight	127 g/m^2 (26 lb/1000 sq ft)	Pulp Yield	89%
Production	300 MDMT/day; 100,000 MDMT/yr	Mill Location	North Central
Net Operating Days	330/yr	Boundary Limits	S/F preparation through board making

CAPITAL REQUIREMENTS* ($000)

Physical Plant	22,100	
Other Fixed Capital	2,200	
Total Fixed Capital		24,000
Working Capital		4,000
Total Capital Required		28,000

ENERGY REQUIREMENTS (per MDMT)

	Steam (kg)	Power (kWh)
Pulping	–	230
Board Making	4,000	80
Effluent Treatment	–	30
Misc. & Auxiliaries	600	215
Total	4,600	555

*Totals may not add due to rounding.

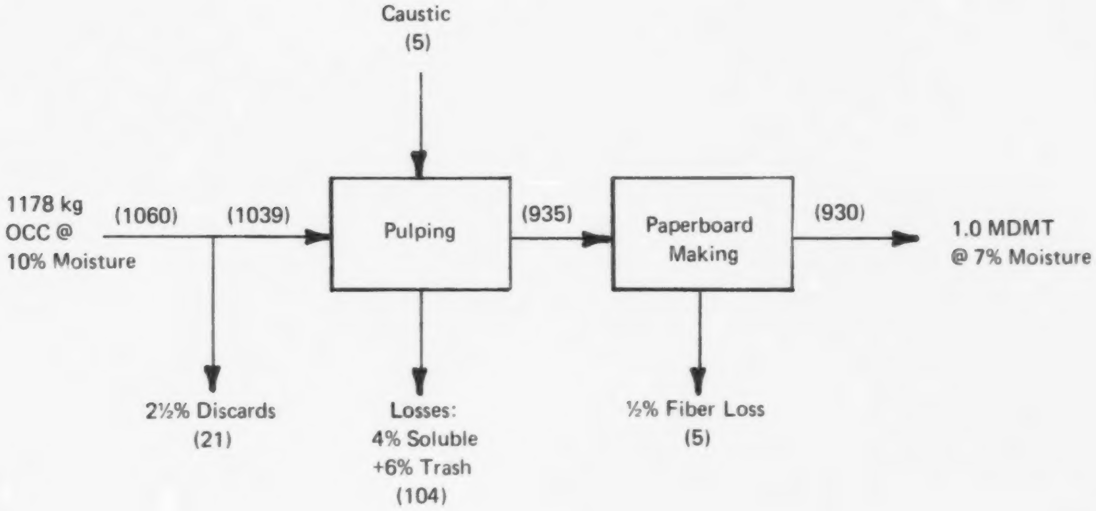
OPERATING COST ($/MDMT)

Fiber Furnish	64.9	
Other Raw Materials	3.5	
Total Raw Materials Cost		68.4
Labor + Fringe @ 32% of Hourly Rate	11.2	
Supplies	6.7	
Energy	26.5	
Factory Overhead	6.3	
Total Conversion Costs		50.7
Capital-Related Costs		18.5
• Total Factory Operating Cost		137.6 ($124.8/MDST)
GS&A	7.0	
Freight Out	12.0	
Total Cost of Sales		19.0
• Total Delivered Cost		156.6 ($142.0/MDST)

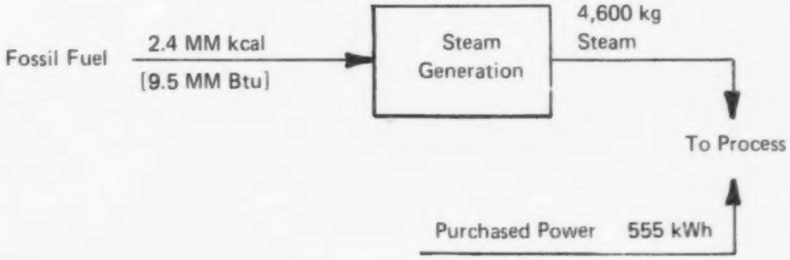
FIG. IX-E-16

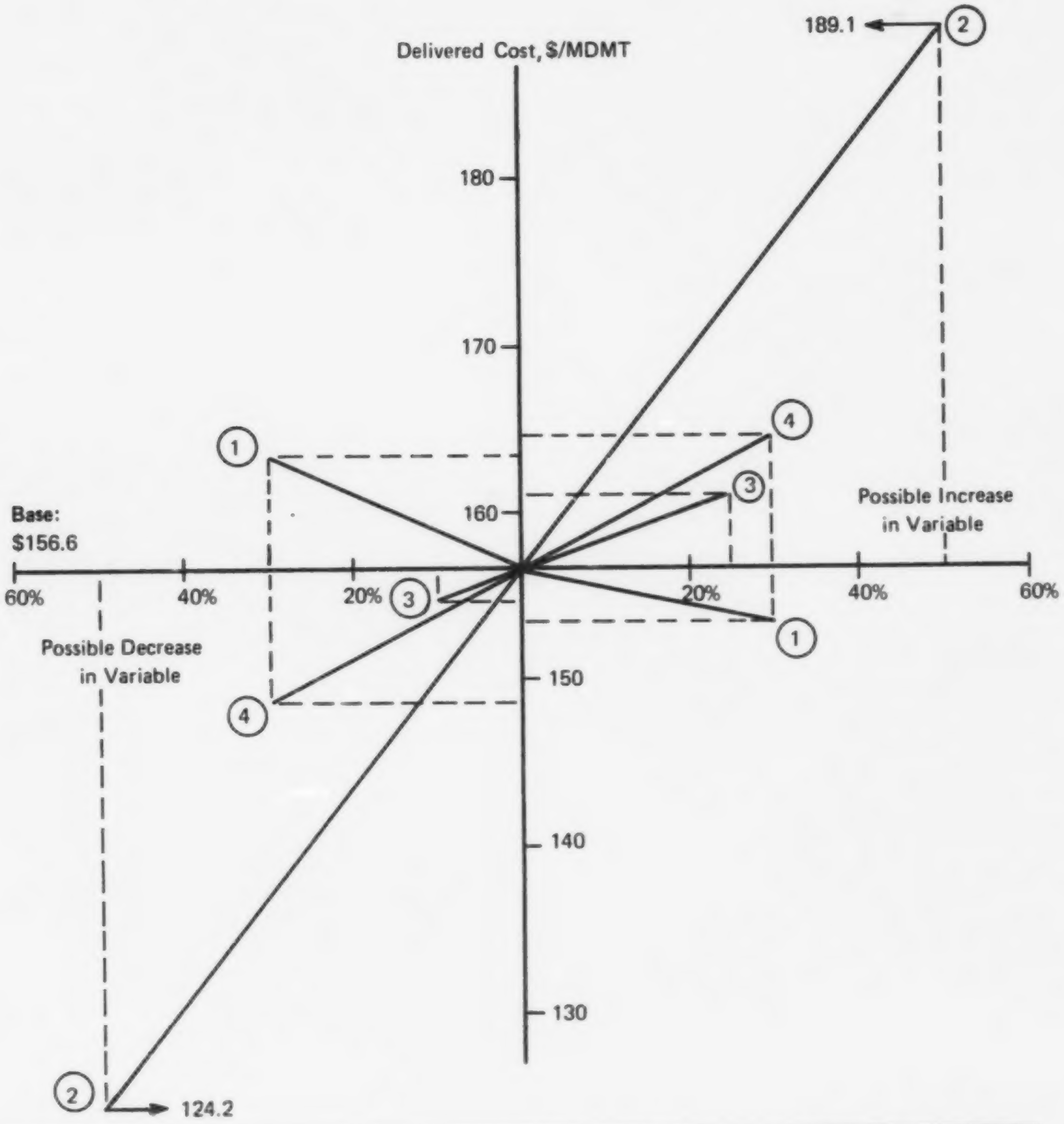
MATERIAL AND ENERGY BALANCE

(Basis: 1.0 MDMT corrugating medium)


Caustic
(5)
1178 kg
OCC @
10% Moisture
(1060)
(1039)
Pulping
(935)
Paperboard
Making
(930)
1.0 MDMT
@ 7% Moisture
2½% Discards
(21)
Losses:
4% Soluble
+6% Trash
(104)
½% Fiber Loss
(5)

( ) indicates BD kg


Fossil Fuel
2.4 MM kcal
[9.5 MM Btu]
Steam
Generation
4,600 kg
Steam
To Process
Purchased Power 555 kWh



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+30, −30	300	390	210
2. Delivered Cost of Fiber, $/ADMT	+50, −50	55	83	28
3. Fixed Capital, $ Million	+25, −10	24	30	22
4. Cost of Energy, $/MMBtu	+30, −30	1.8	2.3	1.3

FIGURE IX-E-17 SENSITIVITY OF THE MANUFACTURING COST OF BOGUS MEDIUM TO KEY VARIABLES

Pages IX-E-42 and IX-E-43 are blank.

TABLE IX-E-15

DESIGN BASIS

Functional Group	Containerboard	Process	NSSC pulping, Na base
Grade	Blended corrugating medium	Fiber Furnish	57% virgin fiber (NSSC), 10% kraft clippings, 33% OCC
Basis Weight	127 g/m^2 (26 lb/1000 sq ft)	Pulp Yield	Unbleached – 75%
Production	410 MDMT/day; 141,000 MDMT/yr	Mill Location	Southeast
Net Operating Days	345/yr	Boundary Limits	Wood & S/F preparation through board making

CAPITAL REQUIREMENTS* (\$000)

Physical Plant	39,600	
Other Fixed Capital	4,000	
Total Fixed Capital		44,000
Working Capital		5,000
Total Capital Required		49,000

ENERGY REQUIREMENTS (per MDMT)

	Steam (kg)	Power (kWh)
Wood Preparation	–	70
Pulping (NSSC)	700	100
(S/F)	–	80
Stock Preparation	–	100
Board Making	4,000	100
Steam & Power Gen. (incl. recovery & liquor prep.)	1,200	100
Effluent Treatment	–	30
Misc. & Auxiliaries	500	110
Total	6,400	690

OPERATING COST* (\$/MDMT)

Fiber Furnish	44.7		
Other Raw Materials	10.5		
Total Raw Materials Cost		55.2	
Labor + Fringe @ 32% of Hourly Rate	19.4		
Supplies	8.5		
Energy	14.3		
Factory Overhead	8.3		
Total Conversion Costs		50.4	
Capital-Related Costs		23.9	
• Total Factory Operating Cost		129.5	(\$117.5/ MDST)
GS&A	7.0		
Freight Out	14.0		
Total Cost of Sales		21.0	
• Total Delivered Cost		150.5	(\$136.5/ MDST)

*Totals may not add due to rounding.

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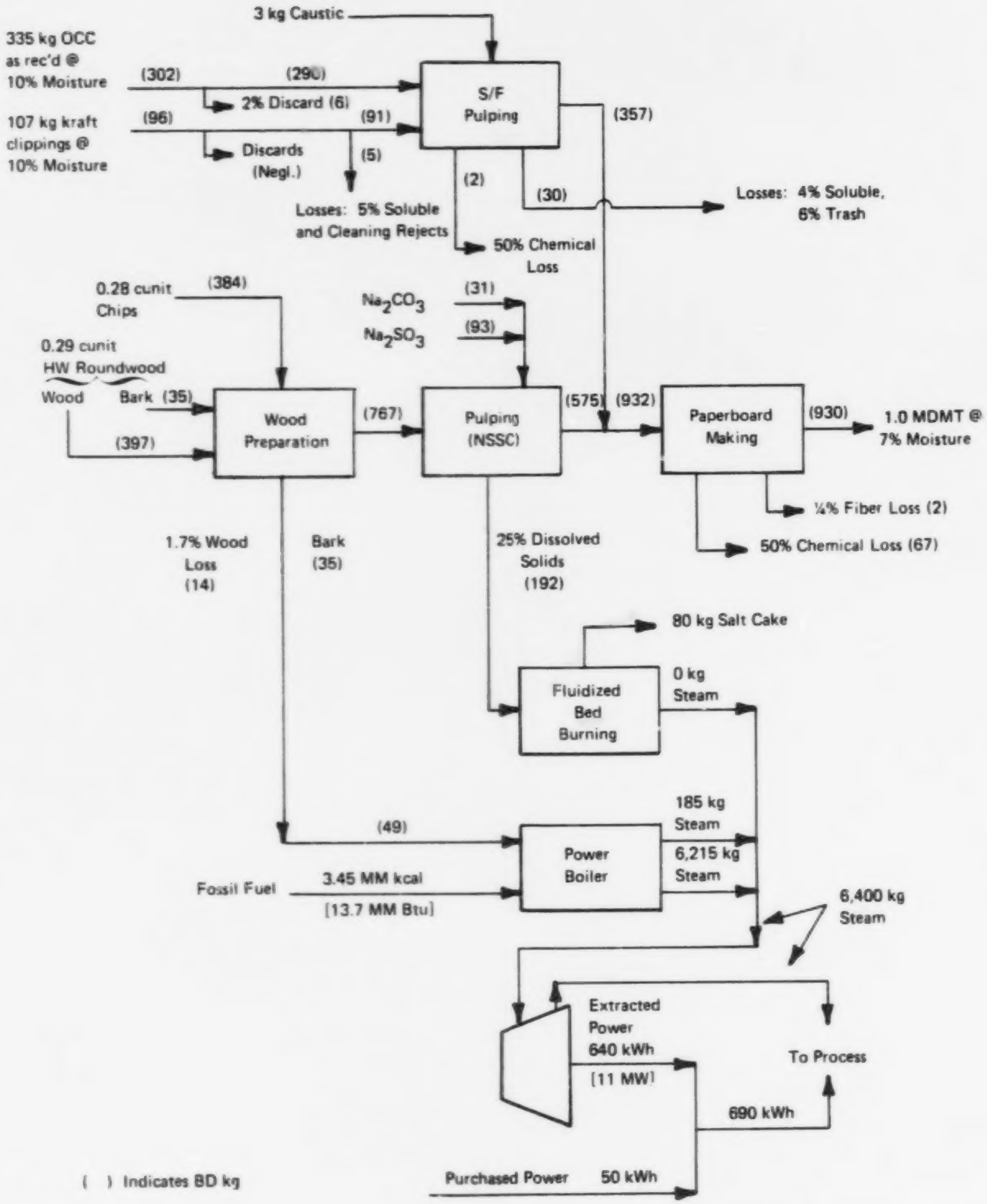
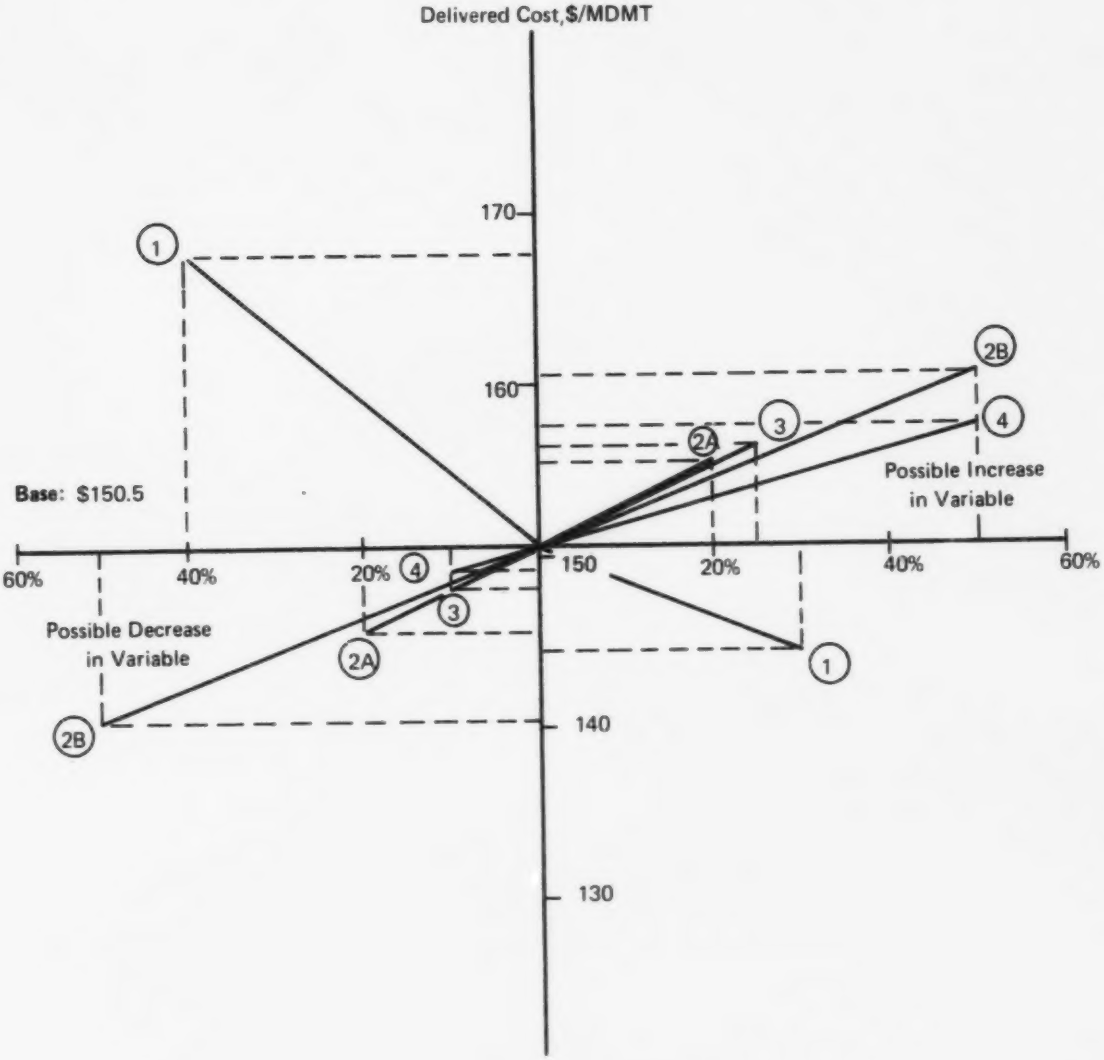
FIGURE IX-E-19

MATERIAL AND ENERGY BALANCE

(Basis: 1.0 MDMT corrugating medium)


3 kg Caustic
335 kg OCC as rec'd @ 10% Moisture
(302)
(296)
2% Discard (6)
107 kg kraft clippings @ 10% Moisture
(96)
(91)
Discards (Negl.)
(5)
S/F Pulping
(357)
(2)
(30)
Losses: 5% Soluble and Cleaning Rejects
50% Chemical Loss
Losses: 4% Soluble, 6% Trash
0.28 cunit Chips
(384)
0.29 cunit HW Roundwood
Wood
Bark (35)
(397)
Wood Preparation
(767)
Na_2CO_3
(31)
Na_2SO_3
(93)
Pulping (NSSC)
(575)
(932)
Paperboard Making
(930)
1.0 MDMT @ 7% Moisture
¼% Fiber Loss (2)
50% Chemical Loss (67)
1.7% Wood Loss (14)
Bark (35)
25% Dissolved Solids (192)
80 kg Salt Cake
Fluidized Bed Burning
0 kg Steam
(49)
Power Boiler
185 kg Steam
6,215 kg Steam
Fossil Fuel
3.45 MM kcal
[13.7 MM Btu]
6,400 kg Steam
Extracted Power 640 kWh
[11 MW]
690 kWh
To Process
Purchased Power 50 kWh
( ) Indicates BD kg



KEY VARIABLES		Percent Variation	Best Guess	Possible High	Possible Low
1.	Scale of Operations, MTPD	+30, −40	410	530	245
2. A	Delivered Cost of Fiber,* $/Cunit	+20, −20	30	36	24
	$/ADMT		70	84	56
B	ADMT	+50, −50	60	90	30
3.	Fixed Capital, $ Million	+25, −10	44	55	40
4.	Cost of Energy, $/MMBtu	+50, −10	1.0	1.5	0.9

*2A–Graph Shows Combined Total of Virgin Fiber Plus Kraft Clippings
2B–OCC

FIGURE IX–E–20 SENSITIVITY OF THE MANUFACTURING COST OF BLENDED MEDIUM TO KEY VARIABLES

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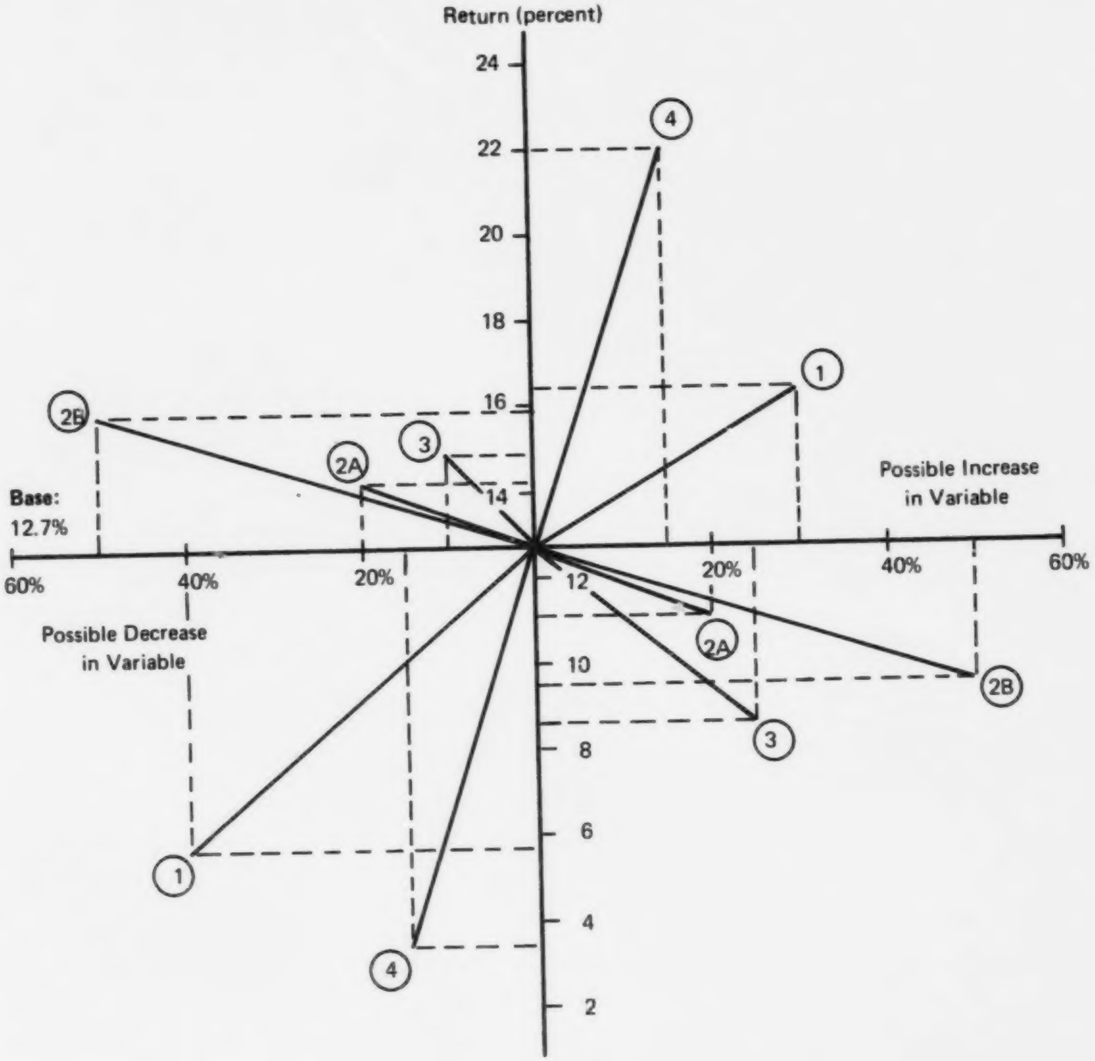

KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+30, −40	410	530	245
2. A Delivered Cost of Fiber,* $/Cunit	+20, −20	30	36	24
$/ADMT		70	84	56
B $/ADMT	+50, −50	60	90	30
3. Fixed Capital, $ Million	+25, −10	44	55	40
4. Selling Price, $/MDMT	+15, −15	190	219	161

*2A–Graph Shows Combined Total of Virgin Fiber Plus Kraft Clippings
2B–OCC

FIGURE IX-E-21 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF BLENDED MEDIUM TO KEY VARIABLES

F. GROUNDWOOD PAPERS

1. Newsprint

a. Basis of Models

Three economic models have been prepared for the production of newsprint--from virgin fiber, secondary fiber, or a blend of both. The products from these models are commodities that serve competitive markets and thus must be of approximately equivalent quality.

Virgin newsprint is commonly made with a predominantly groundwood furnish which includes some chemical fiber, either semi-bleached kraft or sulfite. We have used 75% groundwood and 25% semi-bleached kraft for our model. Industry experience has indicated that 100% waste newsprint, properly cleaned, can be used to make a product of the same quality; thus we have used this as the furnish for our secondary fiber. Since waste newsprint can be used without any deterioration of product quality, furnish for the blended model is somewhat arbitrary; we have used 33% No. 1 news and 67% virgin newsprint furnish (75% groundwood and 25% semi-bleached kraft).

Despite the fact that there is little difference in quality among these products, the marketplace tends to distinguish recycled newsprint by discounting it approximately $5/ton. We have accounted for this difference in our selling price estimate and return on capital calculations, although it would not be likely to hold up under conditions of tight supply. The effect on return on capital by eliminating this price difference can be determined from the sensitivity chart for secondary newsprint

Virgin newsprint is produced in the Northeast, Pacific Northwest, and South. Secondary newsprint is produced in metropolitan areas of the Northeast, North Central, and Southwest. We have chosen a Northeast location for all models because it is typical of the existing industry and offers a common basis for comparison. Regional variations can be evaluated through use of the regional data previously presented (Table IX-C-1) in combination with the sensitivity charts for each model.

The virgin and blended models are sized at 500 MDMT/day to reflect a competitive scale of operation for a new newsprint machine installation. This machine would be integrated to a larger facility that provided chemical fiber furnish, specifically the 730-tpd bleached kraft mill described in Section A.6. The chemical fiber component was transferred at the total slush pulp cost. Similarly, for the virgin groundwood fiber component, pulp was transferred at the total cost for slush pulp manufacture. In this instance we assumed a 400-tpd operation.

For the blended model we have used the same slush pulp unit costs, which presumes that the excess groundwood pulp would be used elsewhere on site. (See Slush Pulp Cost, Section A.6.) Since the blended model represents the newsprint portion of a larger total new mill installation, it is not directly indicative of the economics or possible advantages of adding secondary fiber capacity in a situation where existing machine capacity might be expanded. (See Containerboard, Section E.1.a.) We have not attempted to determine how many machines have the potential for capacity expansion, nor have we idled pulp mill capacity when using secondary fiber in the blended model. The blended model provides a framework from which the potential costs and profitability of adding incremental capacity may be determined, given the specific conditions.

For recycled newsprint, we have set the mill capacity at 300 MDMT/day, based on the existing industry characteristics and on our judgment of the availability of fiber at competitive cost to supply a mill; however, there are no adverse effects from recycling the old news that would limit the capacity of the machine to this level.

b. Comparative Economics

Table IX-F-1 summarizes the total capital, delivered cost, and return on capital for the three newsprint models.

Total fixed capital for the virgin and blended newsprint models of $99 and $92 million respectively includes papermaking, deinking for the blended model, and an allocation of the capital costs for stone groundwood and semi-bleached kraft slush pulp production. On-site power generation is included for both.

Total fixed capital requirement of $40 million for secondary newsprint production is based on a single machine and does not include on-site power, as the total steam requirements are below the minimum we have established for on-site power (see Section C.2.d.) Capital has been included for the deinking and cleaning equipment necessary to make an acceptable product from No. 1 news. The total capital requirements and investment per daily ton for secondary newsprint are considerably lower than for either the virgin or blended models.

The delivered cost for secondary newsprint at $193.6/MDMT is lower than either the virgin model at $204.1 or the blended model at $199.8. This advantage could be increased within the highly volatile range of No. 1 news cost, as demonstrated on the sensitivity chart for delivered cost (Figure IX-F-5) which clearly identifies delivered fiber cost as the most sensitive component.

Of the three models, secondary newsprint has the most attractive return on capital by virtue of its lower total capital and delivered cost. It would become even more attractive with a stable, low-cost source of No. 1 news.

While the blended model is less attractive than 100% S/F, its lower raw material cost compared with 100% virgin fiber indicates that the pulping of No. 1 news is a more economical way to increase pulp capacity than is virgin fiber pulping, provided a stable price and volume of No. 1 news is available. In the manufacture of blended newsprint, return on capital is most sensitive to selling price (Figure IX-F-9); thus, secondary newsprint would have an additional advantage if its price discount were eliminated by a tight supply market.

Power is a large cost component in the manufacture of virgin newsprint. When considering the effect of a possible increase in energy cost, one must determine its impact on the cost of slush pulp manufacture (Section IX-M) as well as on the papermaking operation as reported in this section.

TABLE IX-F-1

Economic Comparison of Newsprint Manufacture

Functional Group	Groundwood Papers		
Grade	Newsprint		
Basis Weight (g/m^2)	49 (30 lb/3000 sq ft)		
Fiber Furnish	100% Virgin	100% Secondary	67% Virgin 33% Secondary
Plant Size (MT/DAY)	500	300	500
Plant Location	Northeast	Northeast	Northeast
Plant Specifics	Integrated	Non-Integrated	Integrated
Total Fixed Capital* ($ Million)	99	40	92
($000/Daily Ton)	198	133	184
Total Delivered Cost ($/MDMT)	204.1	193.6	199.8
Raw Materials ($/MT, delivered)	108.4	66.1	94.1
Conversion ($/MT)	36.9	72.8	44.2
Capital-Related ($/MT)	26.2	30.1	28.9
Sales Cost (less freight) ($/MT)	12.6	12.6	12.6
Freight in ($/MT Product)**	12.7	12.5	12.4
Freight out ($/MT Product)	20.0	12.0	20.0
Selling Price ($/MDMT)	240	235	240
Return on Fixed Capital*, pre-tax (%)	6.2	10.6	7.4

*Including pulping

**Not included in total delivered cost

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Table IX-F-2

DESIGN BASIS

Functional Group	Groundwood Papers	Process	Integrated to semi-bleached kraft
Grade	Newsprint	Fiber Furnish	100% virgin (75% groundwood slush pulp, 25% semi-bleached kraft slush pulp)
Basis Weight	49 g/m^2 (30 lb/3000 sq ft)	Pulp Yield	Groundwood – 95%
Production	500 MDMT/day; 170,000 MDMT/yr	Mill Location	Northeast
Net Operating Days	340/yr	Boundary Limits	Wood preparation and transfer of slush pulp to paper making

CAPITAL REQUIREMENTS* ($000)

Physical Plant	52,700	
Other Fixed Capital	5,300	
Total Fixed Capital		58,000
Working Capital		9,000
Total Capital Required		67,000

ENERGY REQUIREMENTS (per MDMT)

	Steam (kg)	Power (kWh)
Wood Preparation	–	120
Paper Making	2,700	200
Effluent Treatment	–	15
Misc., incl. Auxiliaries	450	15
Total	3,150	350

OPERATING COST* ($/MDMT)

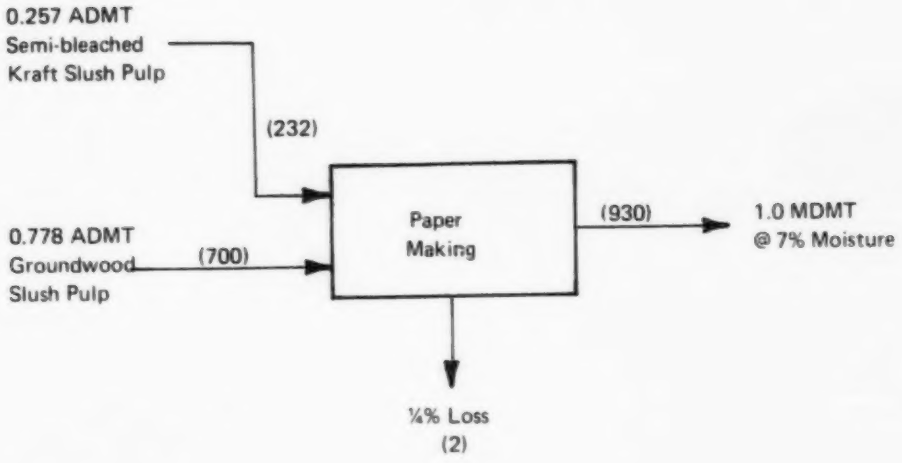
Fiber Furnish	105.5	
Other Raw Materials	2.8	
Total Raw Materials Cost		108.4
Labor + Fringe @ 32% of Hourly Rate	10.0	
Supplies	11.2	
Energy	12.9	
Factory Overhead	2.9	
Total Conversion Costs		36.9
Capital-Related Costs		26.2
• Total Factory Operating Cost		171.5 ($155.6/MDST)
GS&A	12.6	
Freight Out	20.0	
Total Cost of Sales		32.6
• Total Delivered Cost		204.1 ($185.2/MDST)

*Totals may not add due to rounding.

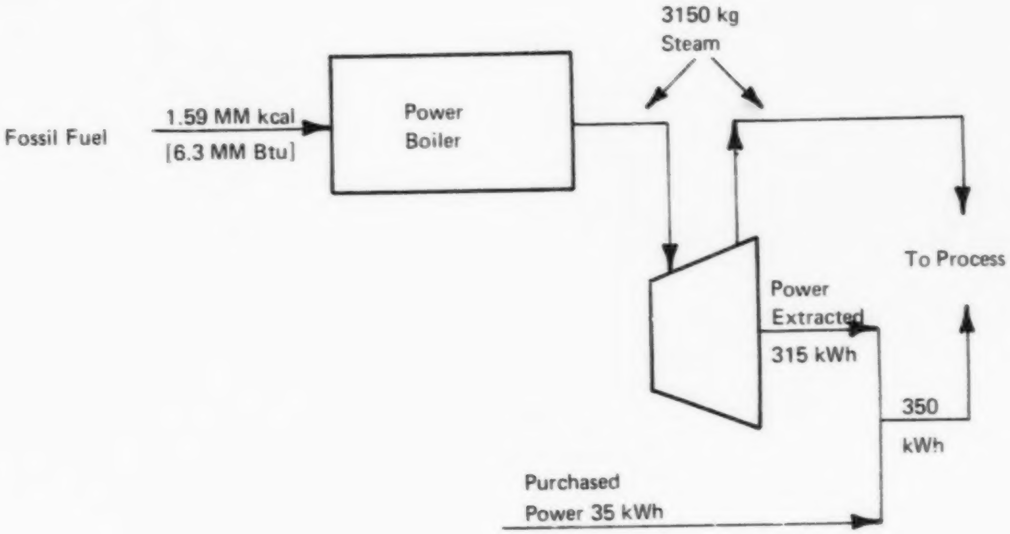
Figure IX-F-1

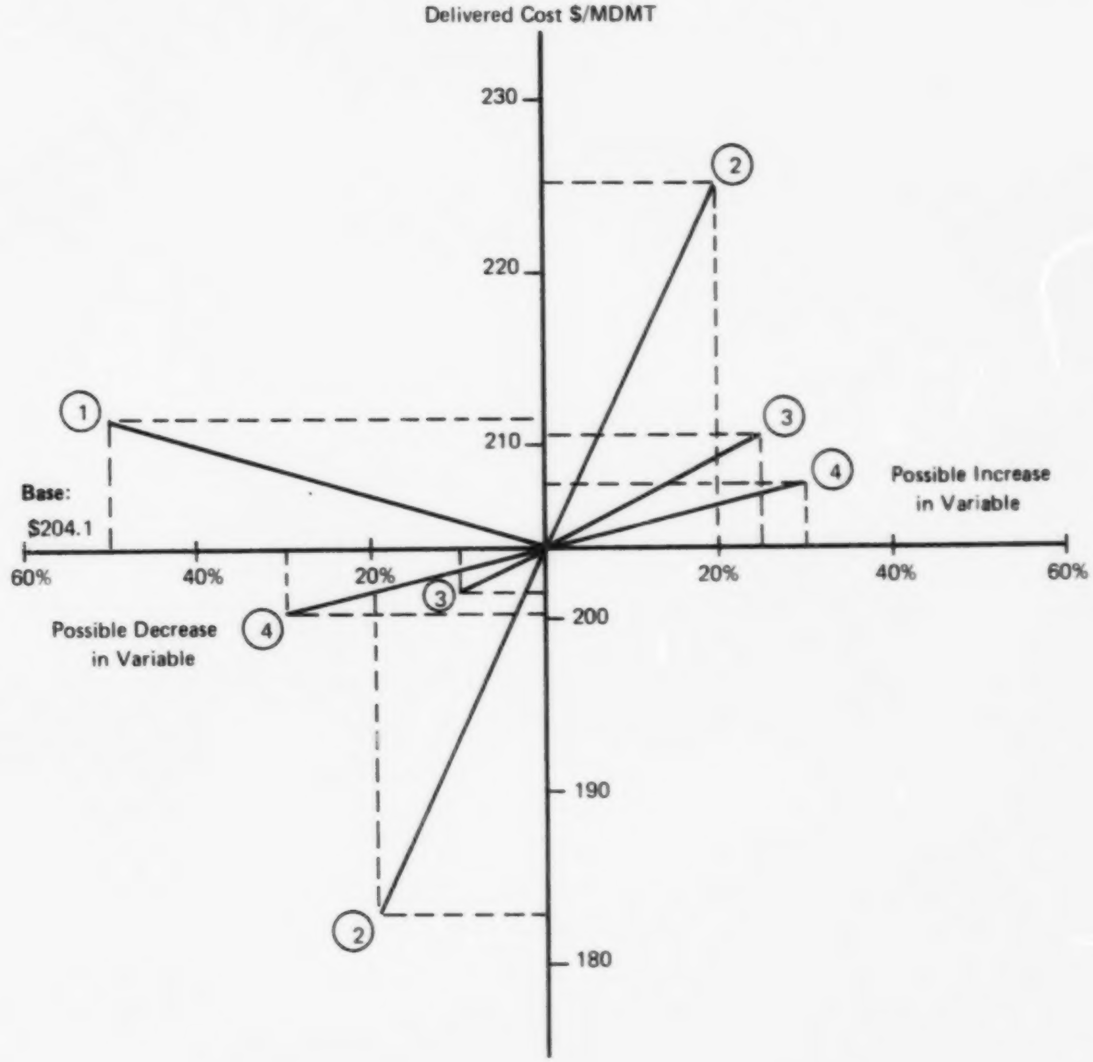
MATERIAL AND ENERGY BALANCE

(Basis: 1.0 MDMT newsprint)


0.257 ADMT
Semi-bleached
Kraft Slush Pulp
(232)
0.778 ADMT
Groundwood
Slush Pulp
(700)
Paper
Making
(930)
1.0 MDMT
@ 7% Moisture
¼% Loss
(2)

( ) Indicates BD kg


3150 kg
Steam
Fossil Fuel
1.59 MM kcal
[6.3 MM Btu]
Power
Boiler
To Process
Power
Extracted
315 kWh
350
kWh
Purchased
Power 35 kWh



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+ 0, −30	500	500	350
2. A Delivered Cost of Fiber,* $/ADMT	+20, −20	153	184	122
B		85	102	68
3. Fixed Capital, $ Million	+25, −10	58	73	52
4. Cost of Energy, $/MMBtu	+30, −30	2.0	2.6	1.4

*2A—SB Kraft, 2B—Groundwood Slush Pulp

FIGURE IX–F–2 SENSITIVITY OF THE MANUFACTURING COST OF NEWSPRINT (VIRGIN) TO KEY VARIABLES

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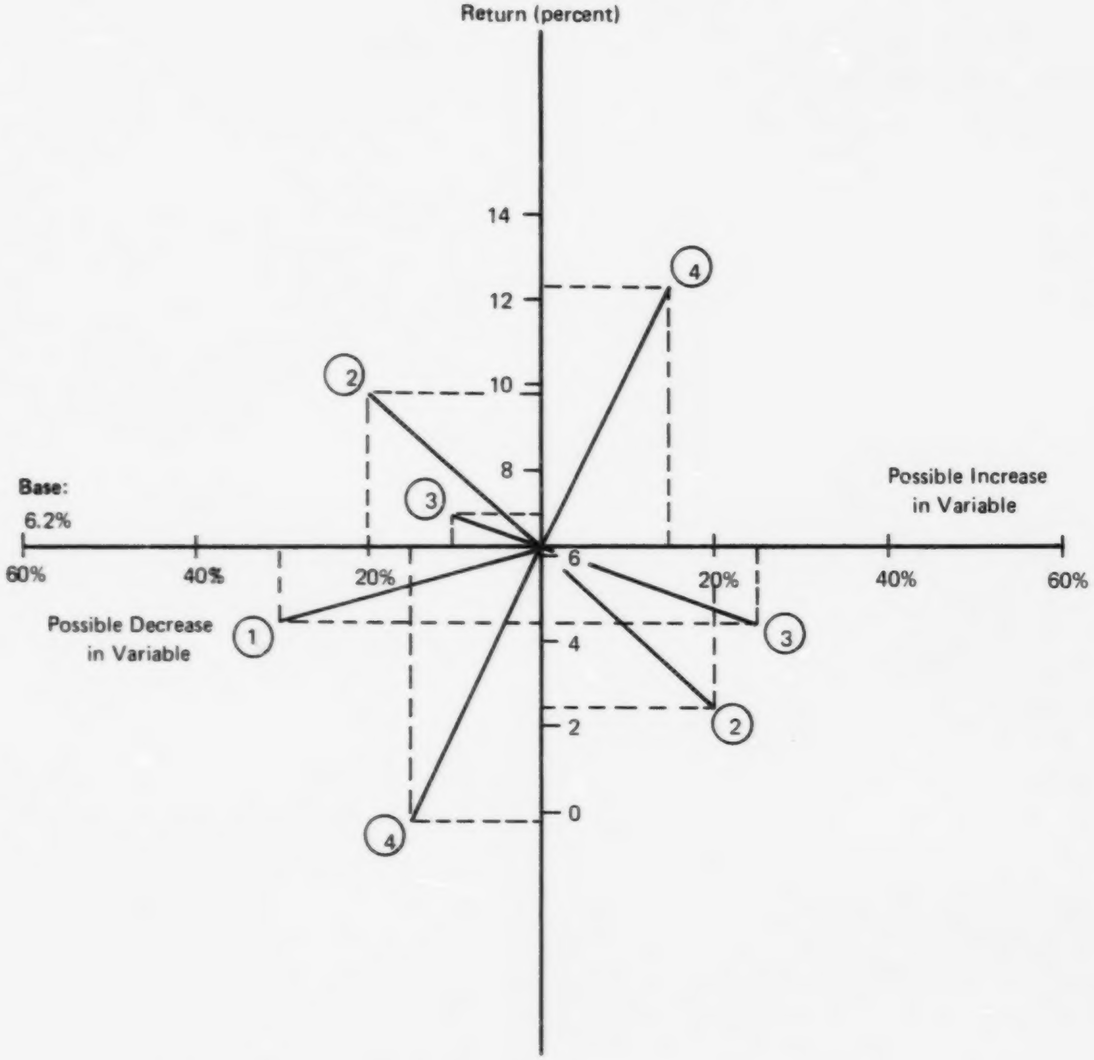


KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations,** MTPD	+ 0, −30	500	500	350
2. A B Delivered Cost of Fiber,* $/ADMT	+20, −20	153 85	184 102	122 68
3. Fixed Capital,** $ Million	+25, −10	58	73	52
4. Selling Price, $/MDMT	+15, −15	240	276	204

*2A–SB Kraft, 2B–Groundwood Slush Pulp

**Variation applies to paper-making operation only; allocated fixed capital for pulp manufacture is assumed constant at $41 million.

FIGURE IX–F–3 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF NEWSPRINT (VIRGIN) TO KEY VARIABLES

Table IX-F-4

DESIGN BASIS

Functional Group	Groundwood Papers	Process	S/F pulping and de-inking
Grade	Newsprint	Fiber Furnish	100% old news
Basis Weight	49 g/m^2 (30 lb/3000 sq ft)	Pulp Yield	80% AD S/F to MD paper
Production	300 MDMT/day; 102,000 MDMT/yr	Mill Location	Northeast
Net Operating Days	340/yr	Boundary Limits	S/F preparation through paper making

CAPITAL REQUIREMENTS* ($000)

Physical Plant	36,600	
Other Fixed Capital	3,700	
Total Fixed Capital		40,000
Working Capital		5,000
Total Capital Required		45,000

ENERGY REQUIREMENTS (per MDMT)

	Steam (kg)	Power (kWh)
Pulping & De-inking	500	420
Paper Making	2,700	200
Effluent Treatment	–	40
Misc., incl. Auxiliaries	600	40
Total	3,800	700

OPERATING COST* ($/MDMT)

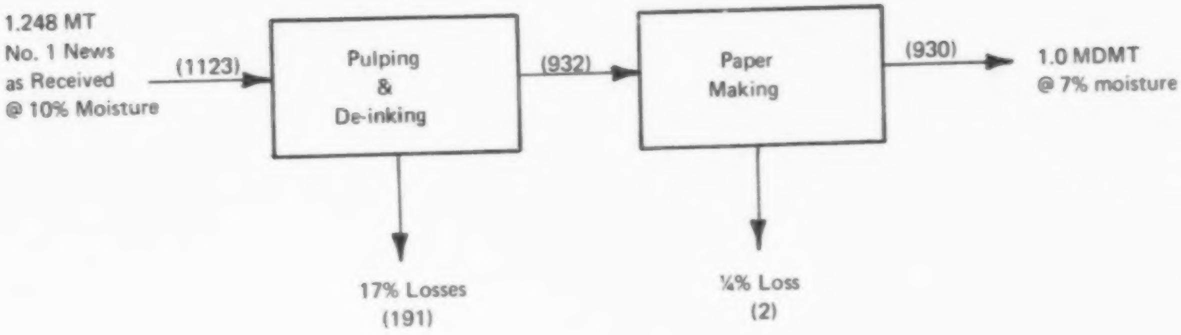
Fiber Furnish	56.3	
Other Raw Materials	9.8	
Total Raw Materials Cost		66.1
Labor + Fringe @ 32% of Hourly Rate	16.4	
Supplies	15.2	
Energy	31.7	
Factory Overhead	9.6	
Total Conversion Costs		72.8
Capital-Related Costs		30.1
• Total Factory Operating Cost		169.0 ($153.3/MDST)
GS&A	12.6	
Freight Out	12.0	
Total Cost of Sales		24.6
• Total Delivered Cost		193.6 ($175.6/MDST)

*Totals may not add due to rounding.

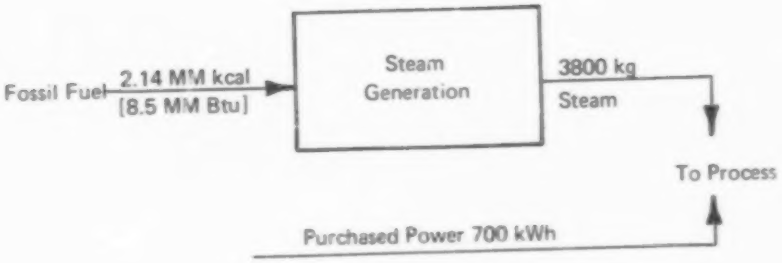
Figure IX-F-4

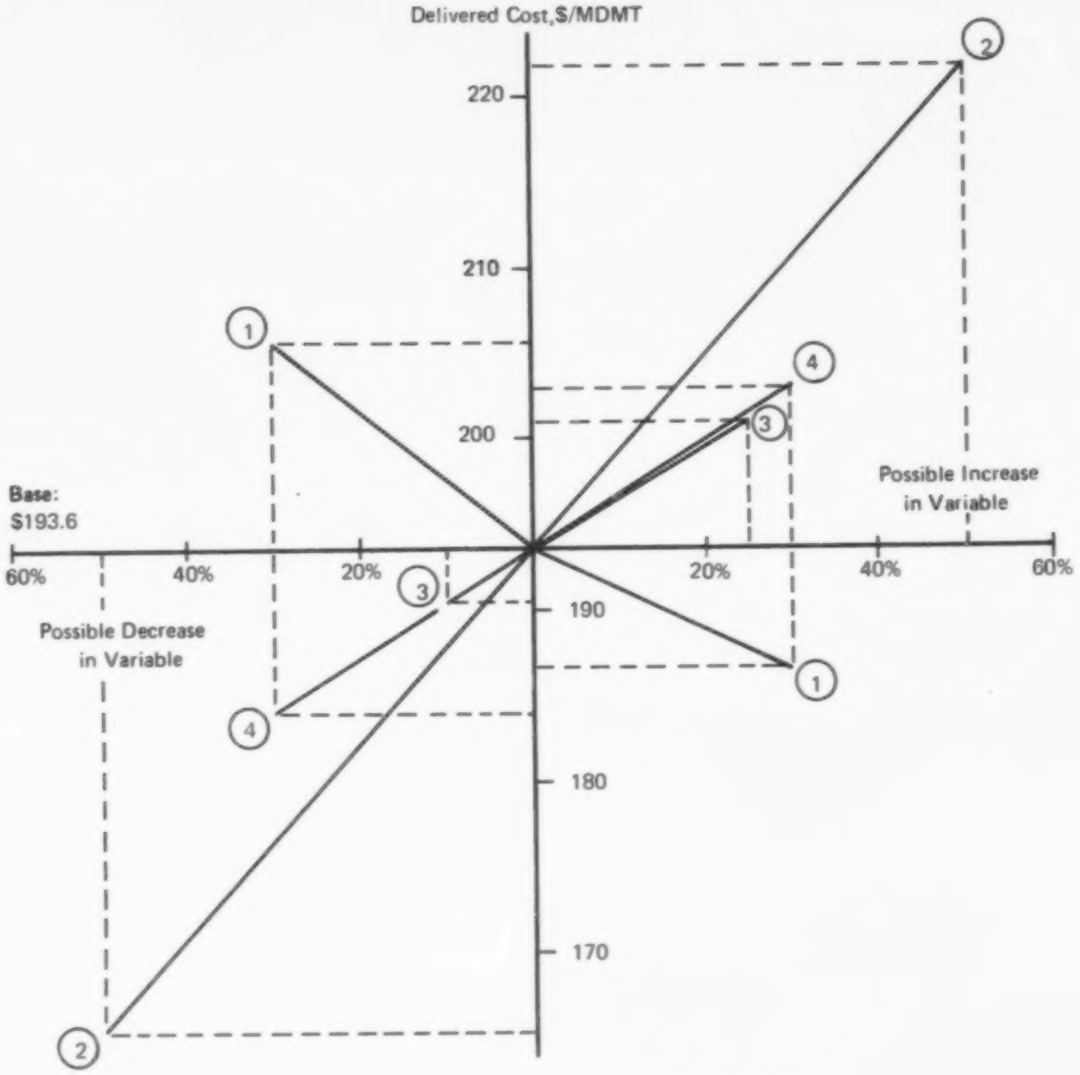
MATERIAL AND ENERGY BALANCE

(Basis: 1.0 MDMT newsprint)


1.248 MT
No. 1 News
as Received
@ 10% Moisture
(1123)
Pulping
&
De-inking
(932)
Paper
Making
(930)
1.0 MDMT
@ 7% moisture
17% Losses
(191)
¼% Loss
(2)

( ) Indicates BD kg


Fossil Fuel
2.14 MM kcal
[8.5 MM Btu]
Steam
Generation
3800 kg
Steam
To Process
Purchased Power 700 kWh



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+30, −30	300	390	210
2. Delivered Cost of Fiber, $/ADMT	+50, −50	45	68	23
3. Fixed Capital, $ Million	+25, −10	40	50	36
4. Cost of Energy, $/MM Btu	+30, −30	2.0	2.6	1.4

FIGURE IX–F–5 SENSITIVITY OF THE MANUFACTURING COST OF NEWSPRINT (SECONDARY) TO KEY VARIABLES

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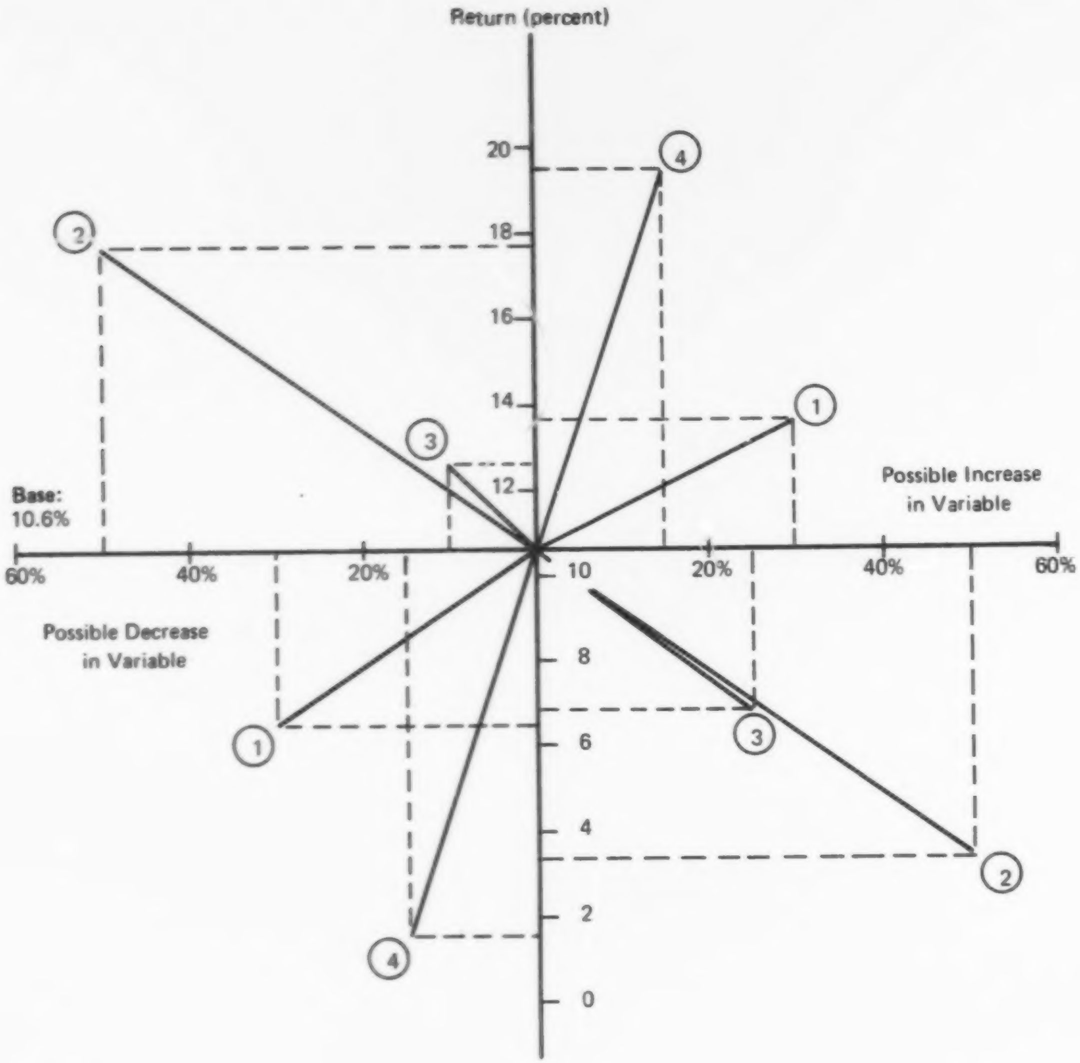


KEY VARIABLES		Percent Variation	Best Guess	Possible High	Possible Low
1.	Scale of Operations, MTPD	+30, −30	300	390	210
2.	Delivered Cost of Fiber, $/ADMT	+50, −50	45	68	23
3.	Fixed Capital, $ Million	+25, −10	40	50	36
4.	Selling Price, $/MDMT	+15, −15	235	270	200

FIGURE IX–F–6 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF NEWSPRINT (SECONDARY) TO KEY VARIABLES

Table IX-F-6

DESIGN BASIS

Functional Group	Groundwood Papers	Process	Newsprint de-inking, integrated to semi-bleached kraft
Grade	Newsprint	Fiber Furnish	67% Virgin (50% groundwood slush pulp, 17% SBK slush pulp), 33% S/F
Basis Weight	49 g/m^2 (30 lb/3000 sq ft)	Pulp Yield	80% AD S/F to MD paper
Production	500 MDMT/day; 170,000 MDMT/yr	Mill Location	Northeast
Net Operating Days	340/yr	Boundary Limits	S/F preparation and transfer of slush pulp through paper making

CAPITAL REQUIREMENTS*
($000)

Physical Plant	58,500	
Other Fixed Capital	5,900	
Total Fixed Capital		64,000
Working Capital		8,000
Total Capital Required		72,000

ENERGY REQUIREMENTS
(per MDMT)

	Steam (kg)	Power (kWh)
Pulping & De-inking	175	190
Paper Making	2,700	200
Effluent Treatment	–	15
Misc., incl. Auxiliaries	525	15
Total	3,400	420

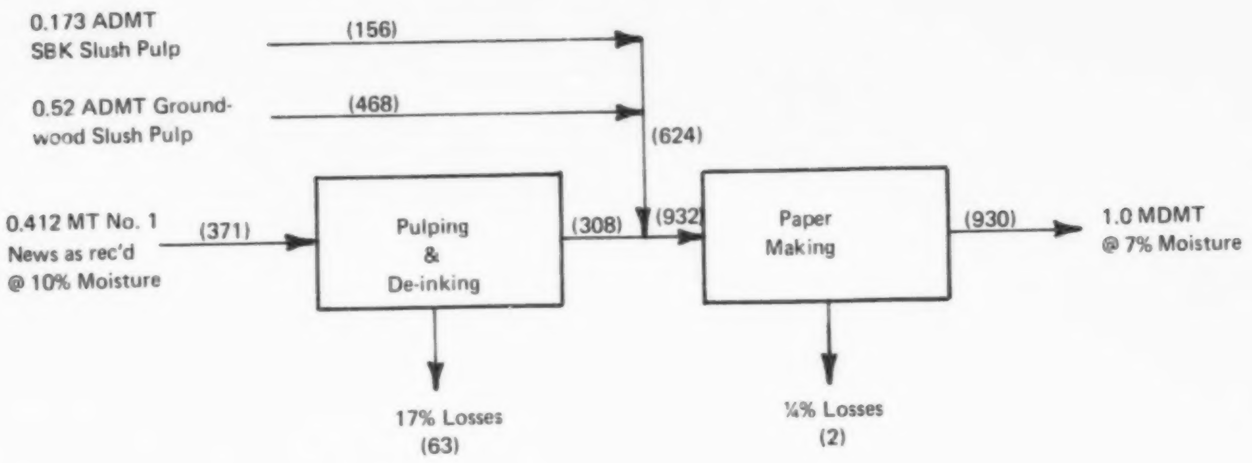
OPERATING COST*
($/MDMT)

Fiber Furnish	89.3	
Other Raw Materials	4.9	
Total Raw Materials Cost		94.1
Labor + Fringe @ 32% of Hourly Rate	11.7	
Supplies	11.8	
Energy	16.7	
Factory Overhead	3.9	
Total Conversion Costs		44.2
Capital-Related Costs		28.9
● Total Factory Operating Cost		167.2 ($151.7/ MDST)
GS&A	12.6	
Freight Out	20.0	
Total Cost of Sales		32.6
● Total Delivered Cost		199.8 ($181.3/ MDST)

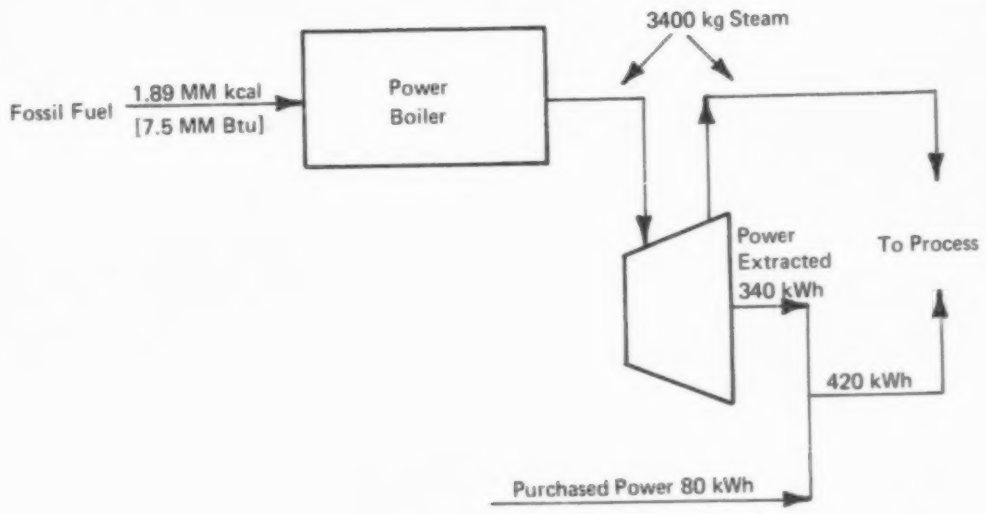
*Totals may not add due to rounding.

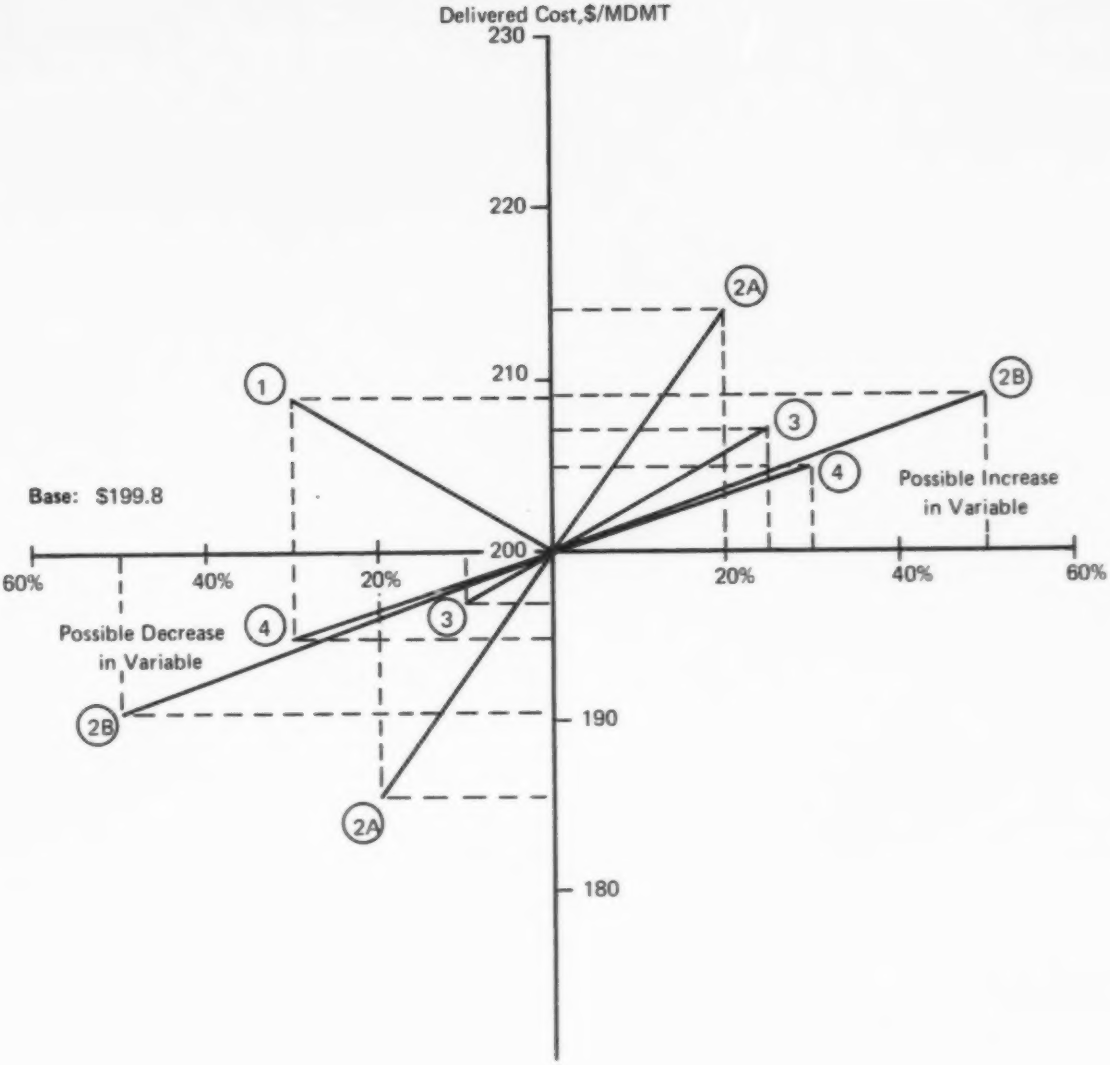
Figure IX-F-7

MATERIAL AND ENERGY BALANCE
(Basis: 1.0 MDMT newsprint)


0.173 ADMT
SBK Slush Pulp
(156)
0.52 ADMT Groundwood Slush Pulp
(468)
(624)
0.412 MT No. 1
News as rec'd
@ 10% Moisture
(371)
Pulping
&
De-inking
(308)
(932)
Paper
Making
(930)
1.0 MDMT
@ 7% Moisture
17% Losses
(63)
¼% Losses
(2)

( ) Indicates BD kg


3400 kg Steam
Fossil Fuel
1.89 MM kcal
[7.5 MM Btu]
Power
Boiler
Power
Extracted
340 kWh
To Process
420 kWh
Purchased Power 80 kWh



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+ 0, −30	500	500	350
2. A Delivered Cost of Fiber, * $/ADMT	+20, −20	102	122	82
B	+50, −50	45	68	23
3. Fixed Capital, $ Million	+25, −10	64	80	58
4. Cost of Energy, $/MM Btu	+30, −30	2.0	2.6	1.4

*2A–Virgin (Average Slush Pulp Cost), 2B–Secondary Fiber

FIGURE IX–F–8 SENSITIVITY OF THE MANUFACTURING COST OF NEWSPRINT (BLENDED) TO KEY VARIABLES

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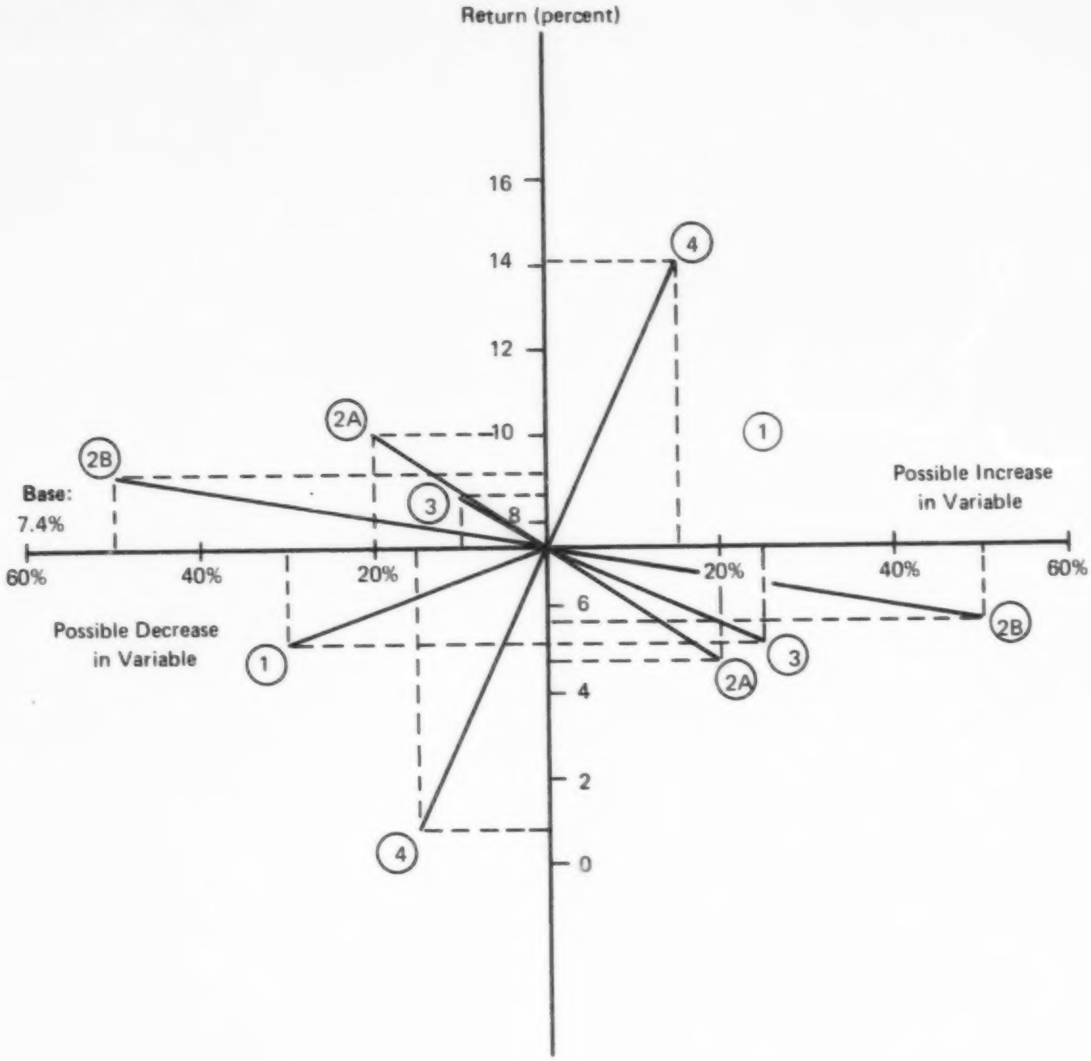


KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations,** MTPD	+ 0, −30	500	500	350
2. A Delivered Cost of Fiber,* $/ADMT	+20, −20	102	122	82
B	+50, −50	45	68	23
3. Fixed Capital,** $ Million	+25, −10	64	80	58
4. Selling Price, $/MDMT	+15, −15	240	276	204

*2A—Virgin (Average Slush Pulp Cost), 2B—Secondary Fiber

**Variation applies to paper-making operation only; allocated fixed capital for pulp manufacture is assumed constant at $28 million.

FIGURE IX–F–9 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF NEWSPRINT (BLENDED) TO KEY VARIABLES

2. Uncoated Printing Paper

a. Basis of Models

Economic models have been prepared for the production of uncoated groundwood printing papers from virgin fiber, secondary fiber, or a blend of both. This product is made in a variety of grades to suit the specific requirements of diverse markets. We have selected the same grade for each of our models, so that the products would serve competitive markets and of necessity be of approximately equivalent quality.

Virgin groundwood printing papers are commonly made with a substantial groundwood furnish, from 25% to 75%; the remainder is chemical fiber, either semi-bleached kraft or sulfite. We have used 65% groundwood and 35% semi-bleached kraft for our model. We have selected a fiber furnish of 80% No. 1 news and 20% white ledger for our secondary fiber model; this is based on industry experience that No. 1 news, properly cleaned, is equivalent to newsprint furnish (75% groundwood, 25% chemical fiber) and that white ledger is somewhat inferior to softwood chemical fiber. For the blended model, we have used a furnish of 41% groundwood, 26% semi-bleached kraft, and 33% No. 1 news. This corresponds to replacing 33% of the total furnish with No. 1 news, having a quality equal to 75% groundwood and 25% SBK.

Despite the fact that we have selected the fiber furnish for these models to eliminate quality differences, the marketplace tends to distinguish recycled printing papers by discounting them approximately 10%. We have accounted for this in our selling price estimate and return on capital calculations, although it would not be likely to hold up under conditions of tight supply. If this price difference were eliminated, the effect on return on capital can be determined from the sensitivity chart for the secondary fiber model (Figure IX-F-15.)

Virgin groundwood printing papers are produced in all regions of the country. There is no specific geographic constraint on the location of mills for making this grade from secondary fiber, except that the logistics of fiber supply would be favored by a metropolitan location. We have located all models in the Northeast as representative of existing industry patterns and offering a common basis for comparison. Regional variations can be evaluated through use of the regional data previously presented. (Table IX-C-1), in combination with the sensitivity charts for each model.

The virgin and blended models are sized at 272 MDMT/day to reflect a competitive scale of operations for a new printing paper machine installation. This machine would be integrated to a larger facility that provided chemical fiber furnish. In both cases we have integrated the model to a 400-ADMT/day groundwood slush pulp mill and a 730-ADMT/day kraft mill, with the excess groundwood and kraft slush pulp used elsewhere on site (see Slush Pulp Cost, Section A.6.) Since the blended model represents the printing paper portion of a larger total new mill installation, it is not directly indicative of the economics or the possible advantages of adding secondary fiber capacity in a situation where existing machine capacity might be expanded (see Containerboard, Section E.2.a.)

We have not attempted to determine how many machines have the potential for capacity expansion, nor have we idled pulp mill capacity when replacing virgin with secondary fiber. The blended model provides the framework from which the potential costs and profitability of adding incremental capacity may be determined, given the specific conditions.

For secondary groundwood printing papers, we have selected mill capacity at 136 MDMT/day to reflect the fact that secondary printing products typically serve specialized markets and are made on machines that are smaller than those used for virgin fiber. Although fiber availability would not limit the mill to this specific size, it would be a prime factor in the scale of operations for the secondary fiber model. The paper machine is not limited to this size by technical considerations.

b. Comparative Economics

Table IX-F-8 summarizes the total capital, delivered cost, and return on capital for the three uncoated groundwood printing paper models. Total fixed capital for the virgin and blended models of $59 million includes papermaking, deinking for the blended model, and an allocation of the capital costs for stone groundwood and semi-bleached kraft slush pulp production. On-site power generation is included for both. However, the power requirements for groundwood slush pulp production greatly exceed the capability for power generation. Because of this high power requirement, we have estimated purchased power cost for groundwood slush pulp at $0.01 kWh, well below the average regional rate of $0.021 kWh.

Total fixed capital requirement for the secondary fiber model of $33 million is based on a single machine and does not include on-site power, as the total steam requirements are below the minimum we have established for on-site power (see Section C.2.d.) Capital has been included for the deinking and cleaning equipment necessary to make an acceptable product from No. 1 news. The total capital requirements for this model are lower than for the virgin or blended models; however, because the plant size is only half that of the other models, it has a higher investment per daily ton.

The delivered cost for secondary groundwood printing papers at $324.6/MDMT is higher than either the virgin product at $269.0 or the blended product at $268.6. This model also has other disadvantages. Although it has the lowest raw material cost of the three models, it requires the use of expensive white ledger to maintain product quality. The sensitivity chart for delivered cost (Figure IX-F-14) indicates that because of this high and stable cost for white ledger, the possible decrease in delivered cost through fiber cost reductions is not as great as the possible range for No. 1 news alone. The possible advantages in raw material costs are offset by the high conversion and capital costs associated with a small scale of operations, and by the higher costs of a nonintegrated operation, highlighted by the sensitivity of the secondary model to energy costs. Even with raw material costs at the low end of the range and the scale of operations increased to 177 MDMT/day, the secondary model would not overcome the comparative disadvantages of being nonintegrated.

The pre-tax return on capital of the blended and virgin models are the same at 6.3%. The sensitivity chart for return (Figure IX-F-18) indicates that a low-cost source of No. 1 news would make the blended model more attractive. Its lower raw material cost, and potential for even lower costs and better return with a stable, low-cost source of No. 1 news, indicates that No. 1 news is an attractive source of incremental pulp capacity compared with increased virgin fiber pulping. The secondary fiber model is so heavily disadvantaged by its small, nonintegrated position and dependence on a high-cost raw material that no reasonable circumstances would make it more attractive than either the virgin or blended fiber models; however, a combination of eliminating the selling price differential, increasing the scale of operations, and establishing a stable, low-cost fiber source would make it competitive.

We have included an operating cost estimate only for one additional model, a nonintegrated virgin fiber mill(integrated to groundwood only), using market pulp as the chemical fiber raw material, and we have prepared a summary sheet (Table IX-F-15) to compare it with the 100% secondary fiber model. The costs for the nonintegrated virgin fiber model have been developed by taking the same capacity as the secondary fiber model and substituting market pulp for secondary fiber and groundwood slush pulp for secondary newsprint (No. 1 news), with corresponding reductions in conversion and capital costs. The investment and operating costs for the deinking operation were deleted in developing the costs for the market pulp model.

Thus, the nonintegrated virgin fiber model represents a new single-machine installation. Since this is a hypothetical case not directly representative of either the existing industry or probable capacity expansions, we consider it unrealistic to perform sensitivity and profitability calculations for this model. Our intent in including it is to provide a comparison on an equivalent basis of high-grade pulp substitute deinking waste papers and market pulp as alternative fiber sources for nonintegrated papermaking.

The nonintegrated virgin fiber model provides a framework for estimating actual mill costs, but one must keep in mind that the nonintegrated paper industry has no new or recent installations, and that its production is not accurately characterized by a single-machine operation.

The total delivered cost of $360.3 and raw material cost of $180.4 per metric ton for the nonintegrated virgin fiber model compare with a delivered cost of $324.6 and raw material cost of $109.8 for secondary fiber. These relative cost differences are due to fiber source alone, and would be true at other levels of actual operating cost if the costs of conversion, capital, and sales differed from those in our models.

The fiber cost differences, while not as great as for models using 100% chemical fiber, explain the high cost and extensive utilization of high-grade pulp substitute deinking secondary fiber sources. Thus, the existing nonintegrated paper mills could provide a ready market if new sources of these secondary fiber grades could be developed. Utilization would remain high at much greater secondary fiber tonnages than presently generated, so long as market pulp prices were at a level where our comparison is valid.

TABLE IX-F-8

Economic Comparison of Groundwood Printing Paper Manufacture

Functional Group	Groundwood Papers		
Grade	Uncoated Printing Paper		
Basis Weight (g/m^2)	57 (35 lbs/3000 sq ft)		
Fiber Furnish	100% Virgin	100% Secondary	67% Virgin 33% Secondary
Plant Size (MT/DAY)	272	136	272
Plant Location	Northeast	Northeast	Northeast
Plant Specifics	Integrated	Non-Integrated	Integrated
Total Fixed Capital* ($ Million)	59	33	59
($000/Daily Ton)	216	243	216
Total Delivered Cost ($/MDMT)	269.0	324.6	268.6
Raw Materials ($/MT, delivered)	128.2	109.8	113.1
Conversion ($/MT)	53.3	113.6	62.9
Capital-Related ($/MT)	32.4	56.2	37.6
Sales Cost (less freight) ($/MT)	25.0	25.0	25.0
Freight in ($/MT Product)**	11.7	13.0	11.6
Freight out ($/MT Product)	30.0	20.0	30.0
Selling Price ($/MDMT)	310	280	310
Return on Fixed Capital*, pre-tax (%)	6.3	- 6.1	6.3

* Including pulping and converting

** Not included in total delivered cost

Table IX-F-9

DESIGN BASIS

Functional Group	Groundwood Papers	Process	Integrated to semi-bleached kraft
Grade	Uncoated printing paper	Fiber Furnish	100% Virgin (65% groundwood slush pulp, 35% SBK)
Basis Weight	57 g/m^2 (35 lb/3000 sq ft)	Pulp Yield	n.a.
Production	272 MDMT/day; 90,000 MDMT/yr	Mill Location	Northeast
Net Operating Days	330/yr	Boundary Limits	Transfer of slush pulp through paper making

CAPITAL REQUIREMENTS* ($000)

Physical Plant	34,900	
Other Fixed Capital	4,000	
Total Fixed Capital		38,000
Working Capital		6,000
Total Capital Required		44,000

ENERGY REQUIREMENTS (per MDMT)

	Steam (kg)	Power (kWh)
Paper Making	3,600	380
Effluent Treatment	–	20
Misc. & Auxiliaries	600	20
Total	4,400	420

OPERATING COST* ($/MDMT)

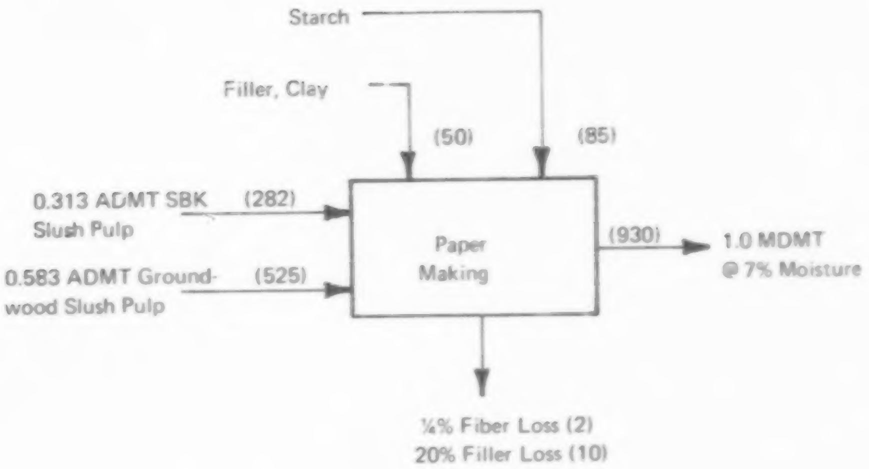
Fiber Furnish	97.5	
Other Raw Materials	30.6	
Total Raw Materials Cost		128.2
Labor + Fringe @ 32% of Hourly Rate	14.6	
Supplies	15.3	
Energy	18.6	
Factory Overhead	4.8	
Total Conversion Costs		53.3
Capital-Related Costs		32.4
• Total Factory Operating Cost		214.0 (194.1/ MDST)
GS&A	25.0	
Freight Out	30.0	
Total Cost of Sales		55.0
• Total Delivered Cost		269.0 ($244.0/ MDST)

*Totals may not add due to rounding

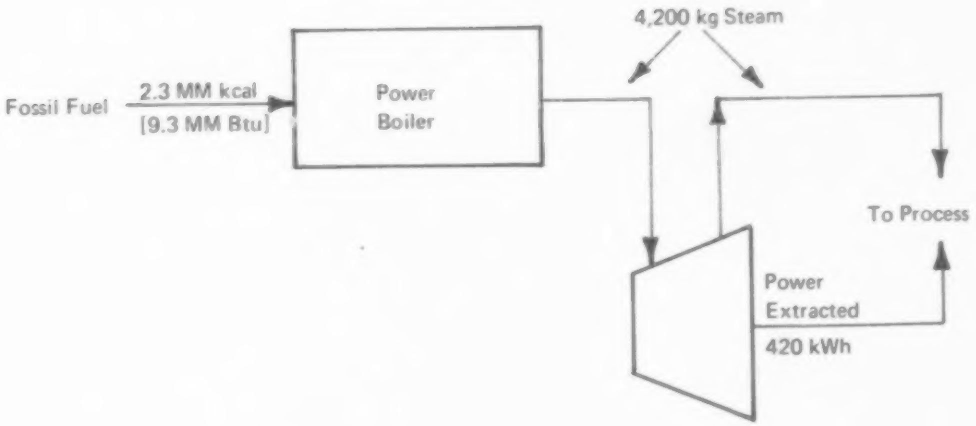
Figure IX-F-10

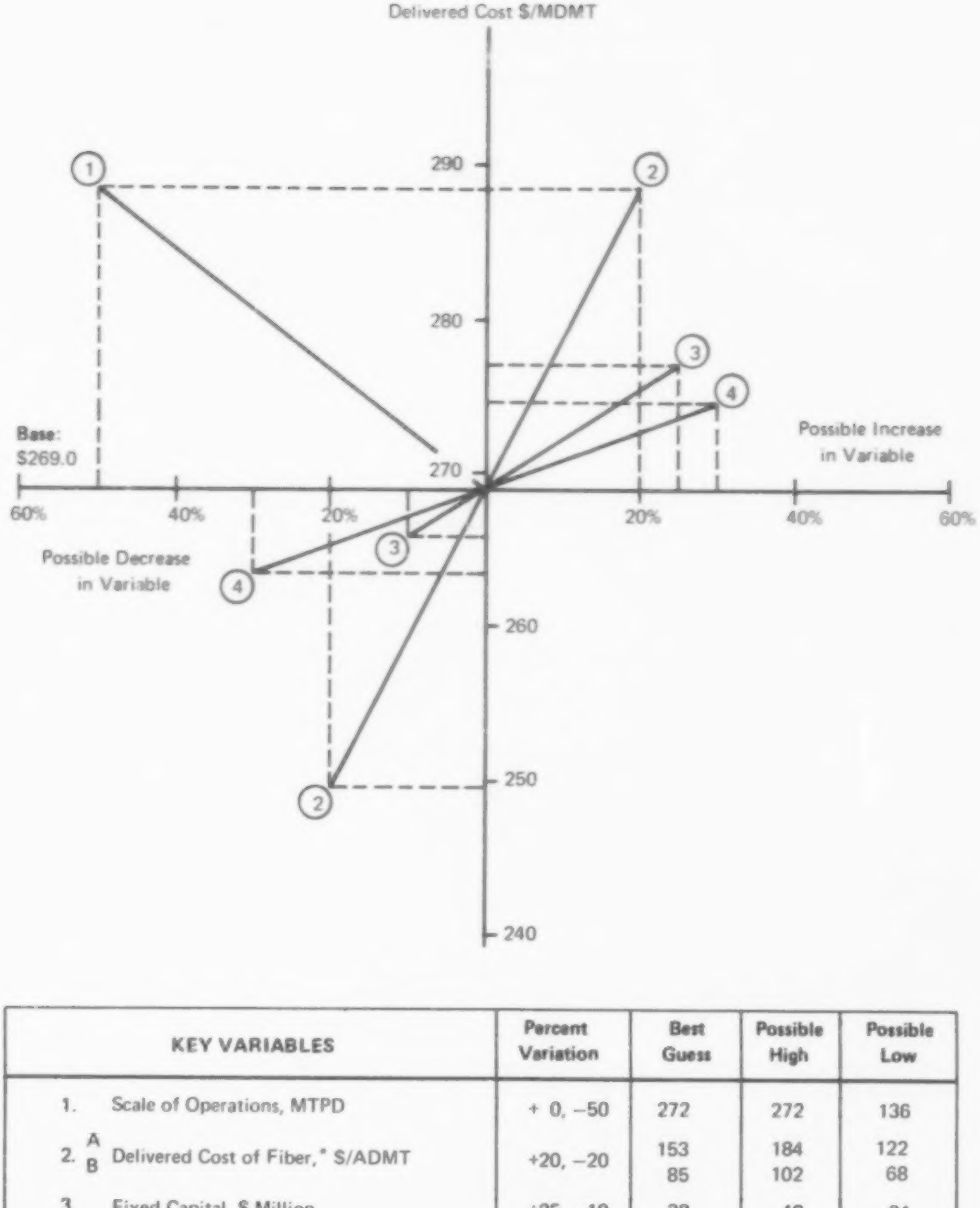
MATERIAL AND ENERGY BALANCE

(Basis: 1.0 MDMT uncoated paper)


Starch
Filler, Clay
(50)
(85)
0.313 ADMT SBK Slush Pulp
(282)
0.583 ADMT Groundwood Slush Pulp
(525)
Paper Making
(930)
1.0 MDMT @ 7% Moisture
¼% Fiber Loss (2)
20% Filler Loss (10)

( ) indicates BD kg


4,200 kg Steam
Fossil Fuel
2.3 MM kcal
[9.3 MM Btu]
Power Boiler
To Process
Power Extracted
420 kWh



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+ 0, −50	272	272	136
2. A B Delivered Cost of Fiber,* $/ADMT	+20, −20	153 85	184 102	122 68
3. Fixed Capital, $ Million	+25, −10	38	48	34
4. Cost of Energy, $/MMBtu	+30, −30	2.0	2.6	1.4

*2A–SB Kraft, 2B–Groundwood Slush Pulp

FIGURE IX–F–11 SENSITIVITY OF THE MANUFACTURING COST OF UNCOATED GROUNDWOOD PRINTING PAPERS (VIRGIN) TO KEY VARIABLES

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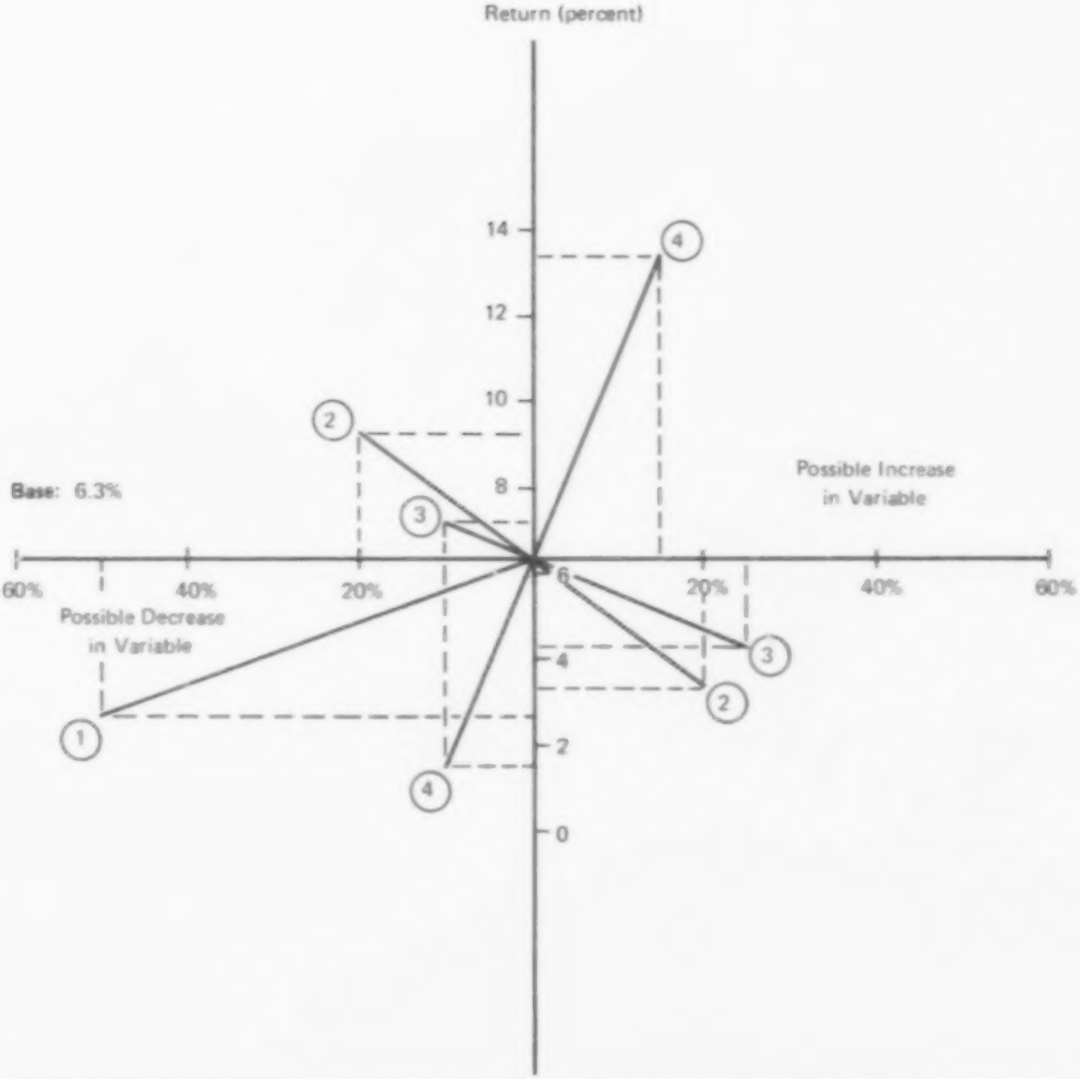


KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations,** MTPD	+ 0, −50	272	272	136
2. A Delivered Cost of Fiber, $/ADMT	+20, −20	153	184	122
B		85	102	68
3. Fixed Capital,** $ Million	+25, −10	38	48	34
4. Selling Price, $/MDMT	+15, −10	310	357	279

*2A–SB Kraft, 2B–Groundwood Slush Pulp

**Variation applies to papermaking operation only; allocated fixed capital for pulp manufacture is assumed constant at $21 million.

FIGURE IX–F–12 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF UNCOATED GROUNDWOOD PRINTING PAPERS (VIRGIN) TO KEY VARIABLES

Table IX-F-11

DESIGN BASIS

Functional Group	Groundwood Papers	Process	S/F pulping and de-inking
Grade	Uncoated printing paper	Fiber Furnish	100% secondary fiber
Basis Weight	57 g/m^2 (35 lb/3000 sq ft)	Pulp Yield	80% AD S/F to MD paper
Production	136 MDMT/day; 45,000 MDMT/yr	Mill Location	Northeast
Net Operating Days	330/yr	Boundary Limits	S/F preparation through paper making

CAPITAL REQUIREMENTS* ($000)

Physical Plant	30,000	
Other Fixed Capital	3,000	
Total Fixed Capital		33,000
Working Capital		4,000
Total Capital Required		37,000

ENERGY REQUIREMENTS (per MDMT)

	Steam (kg)	Power (kWh)
Pulping & De-inking	500	430
Paper Making	3,600	250
Effluent Treatment	–	40
Misc. & Auxiliaries	700	40
Total	4,800	760

OPERATING COST* ($/MDMT)

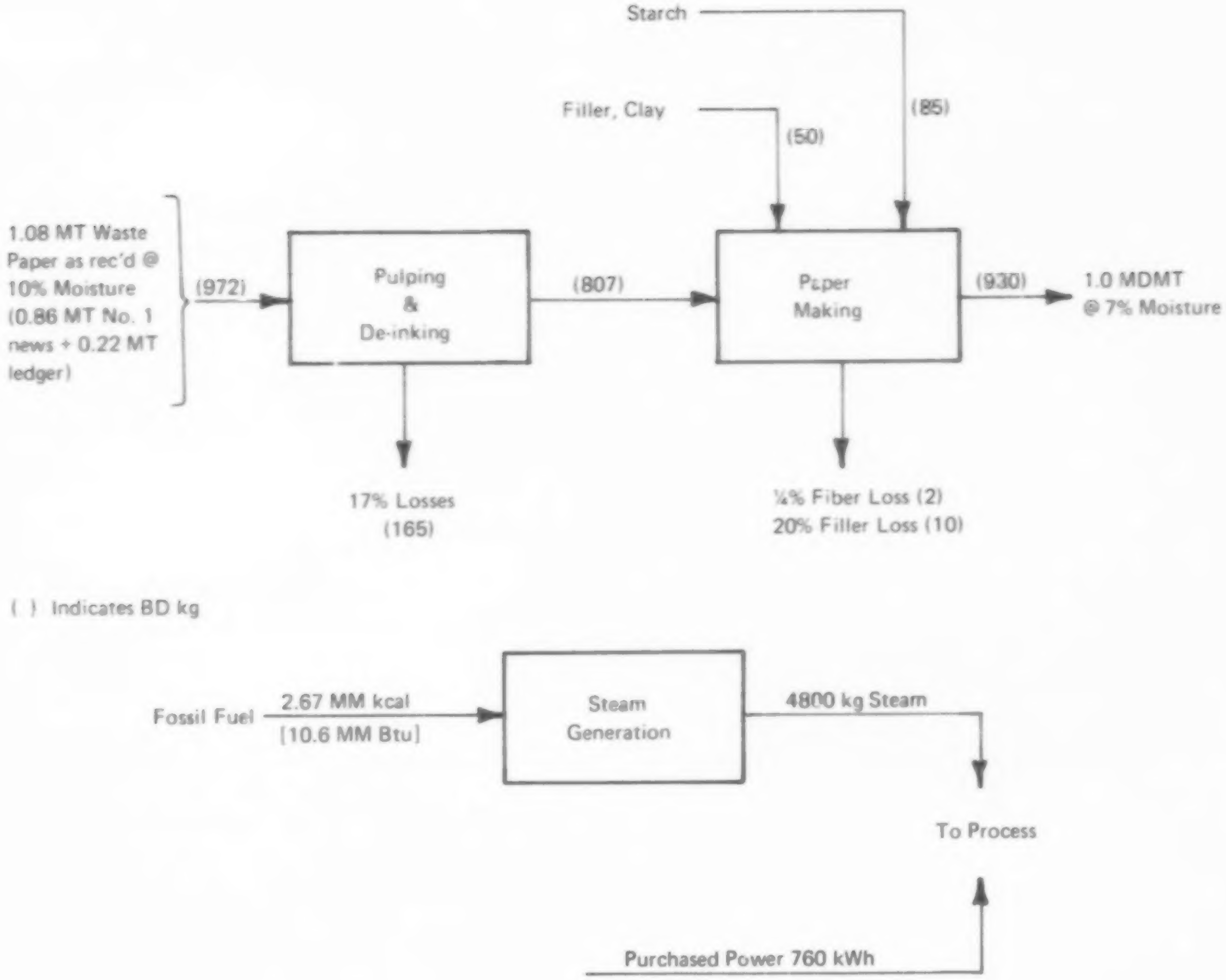
Fiber Furnish	73.2	
Other Raw Materials	36.9	
Total Raw Materials Cost		109.8
Labor + Fringe @ 32% of Hourly Rate	33.1	
Supplies	22.8	
Energy	37.2	
Factory Overhead	20.7	
Total Conversion Costs		113.6
Capital-Related Costs		56.2
● Total Factory Operating Cost		279.6 (253.7/ MDST)
GS&A	25.0	
Freight Out	20.0	
Total Cost of Sales		45.0
● Total Delivered Cost		324.6 ($294.5/ MDST)

*Totals may not add due to rounding

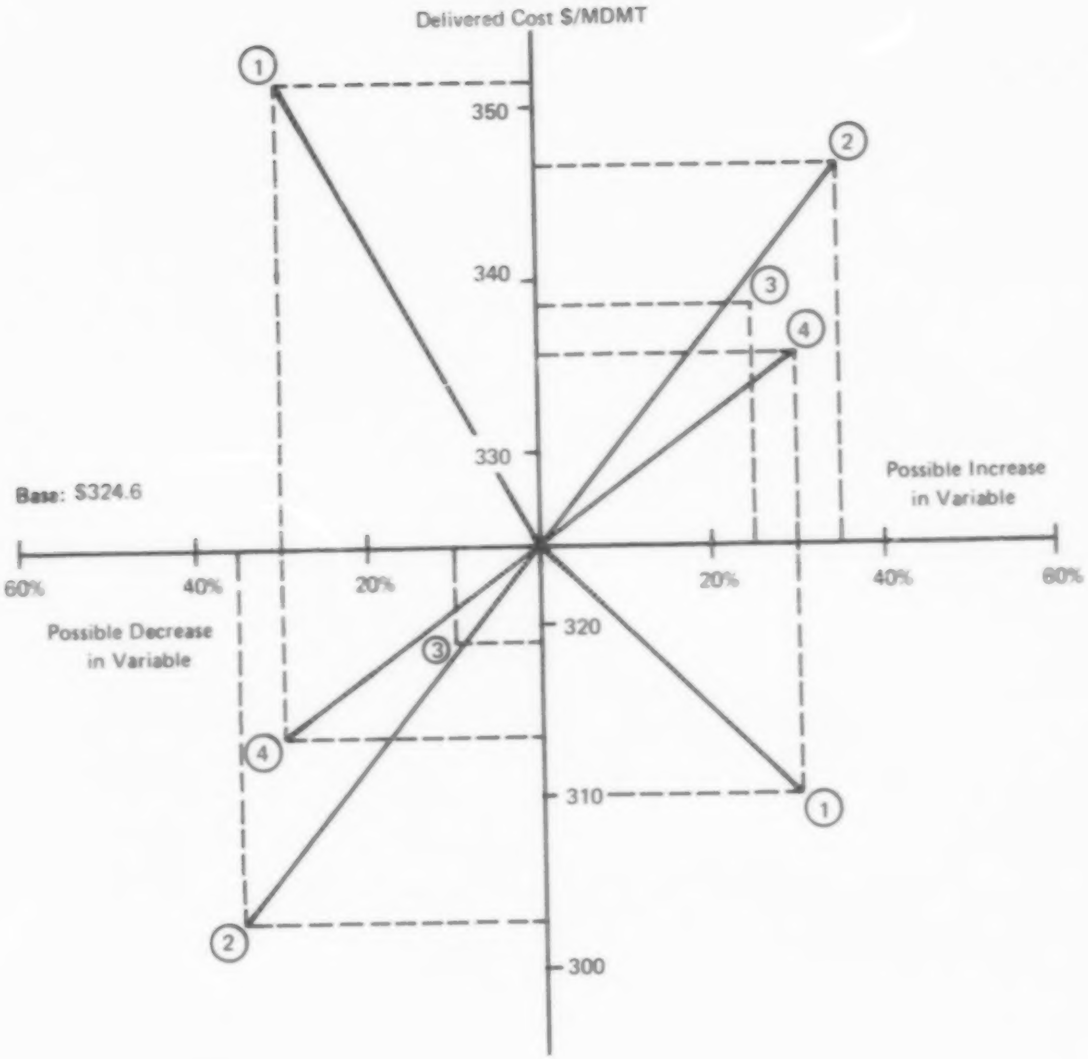
Figure IX-F-13

MATERIAL AND ENERGY BALANCE

(Basis: 1.0 MDMT uncoated paper)


Starch
Filler, Clay
(50)
(85)
1.08 MT Waste Paper as rec'd @ 10% Moisture (0.86 MT No. 1 news + 0.22 MT ledger)
(972)
Pulping & De-inking
(807)
Paper Making
(930)
1.0 MDMT @ 7% Moisture
17% Losses (165)
¼% Fiber Loss (2)
20% Filler Loss (10)
Fossil Fuel
2.67 MM kcal
[10.6 MM Btu]
Steam Generation
4800 kg Steam
To Process
Purchased Power 760 kWh

( ) Indicates BD kg



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+30, – 30	136	177	95
2. A Delivered Cost of Fiber,* $/ADMT	+50, – 50	45	68	23
B	+20, – 20	157	188	126
3. Fixed Capital, $ Million	+25, – 10	33	41	30
4. Cost of Energy, $/MMBtu	+30, – 30	2.0	2.6	1.4

*2A – News, 2B – Ledger (composite variation + 35%, – 35%)

FIGURE IX–F–14 SENSITIVITY OF THE MANUFACTURING COST OF UNCOATED GROUNDWOOD PRINTING PAPERS (SECONDARY) TO KEY VARIABLES

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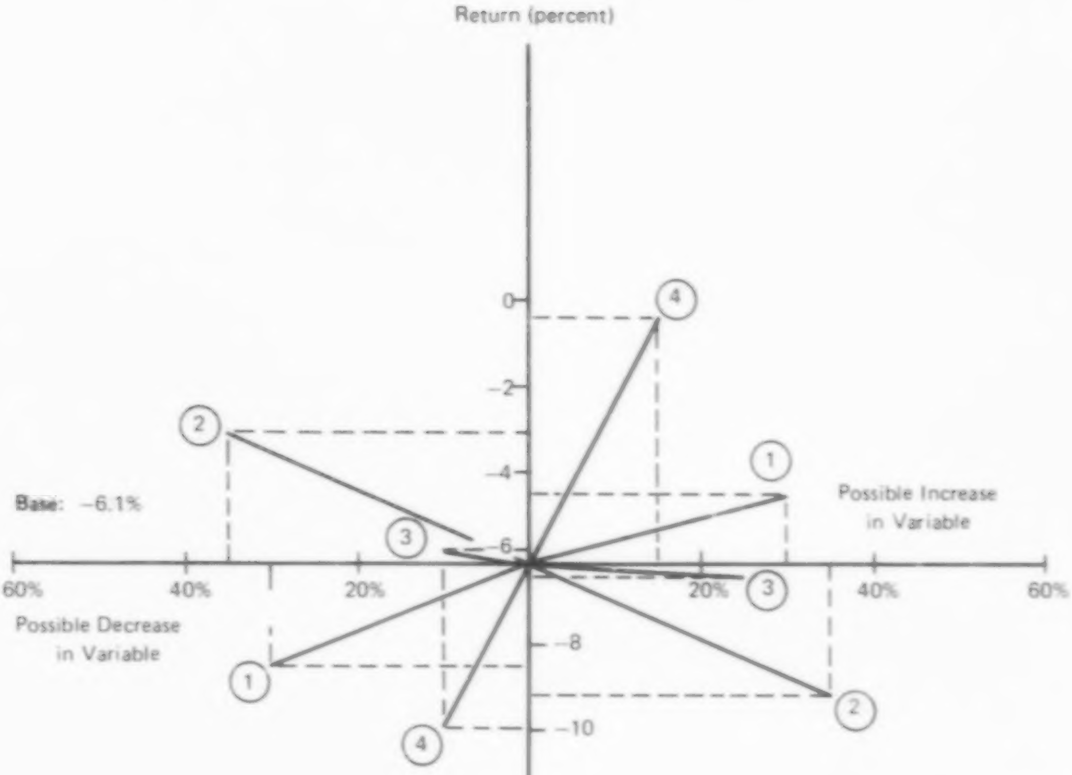


KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+30, −30	136	177	95
2. A B Delivered Cost of Fiber,* $/ADMT	+50, −50 +20, −20	45 157	68 188	23 126
3. Fixed Capital, $ Million	+25, −10	33	41	30
4. Selling Price, $/MDMT	+15, −10	280	322	252

*2A—News, 2B—Ledger (Composite Variation +35%, −35%)

FIGURE IX—F—15 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF UNCOATED GROUNDWOOD PRINTING PAPERS (SECONDARY) TO KEY VARIABLES

Table IX-F-13

DESIGN BASIS

Functional Group	Groundwood Papers	Process	Integrated to semi-bleached kraft
Grade	Uncoated Printing paper	Fiber Furnish	67% Virgin (41% groundwood slush pulp + 26% SBK slush pulp), 33% S/F
Basis Weight	57 g/m^2 (35 lb/3000 sq ft)	Pulp Yield	n.a.
Production	272 MDMT/day; 90,000 MDMT/yr	Mill Location	Northeast
Net Operating Days	330/yr	Boundary Limits	S/F preparation and transfer of slush pulp through paper making

CAPITAL REQUIREMENTS* ($000)

Physical Plant	39,800	
Other Fixed Capital	4,000	
Total Fixed Capital		44,000
Working Capital		6,000
Total Capital Required		50,000

ENERGY REQUIREMENTS (per MDMT)

	Steam (kg)	Power (kWh)
Pulping & De-inking	175	230
Paper Making	3,600	250
Effluent Treatment	–	25
Misc. & Auxiliaries	625	25
Total	4,400	530

OPERATING COST* ($/MDMT)

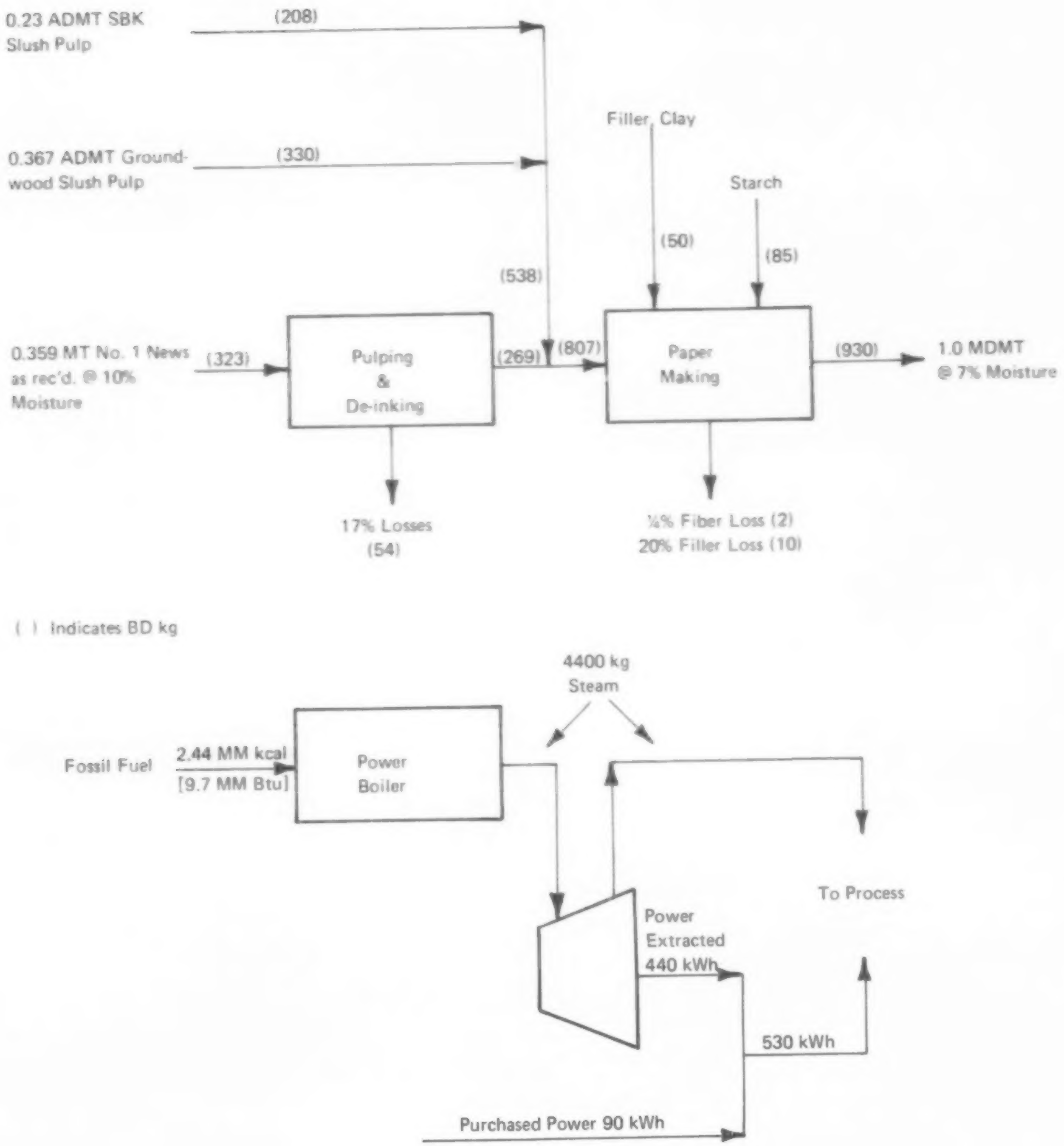
Fiber Furnish	82.4	
Other Raw Materials	30.6	
Total Raw Materials Cost		113.1
Labor + Fringe @ 32% of Hourly Rate	18.4	
Supplies	16.7	
Energy	21.3	
Factory Overhead	6.3	
Total Conversion Costs		62.9
Capital-Related Costs		37.6
● Total Factory Operating Cost		213.6 ($193.8/ MDST)
GS&A	25.0	
Freight Out	30.0	
Total Cost of Sales		55.0
● Total Delivered Cost		268.6 ($243.7/ MDST)

*Totals may not add due to rounding

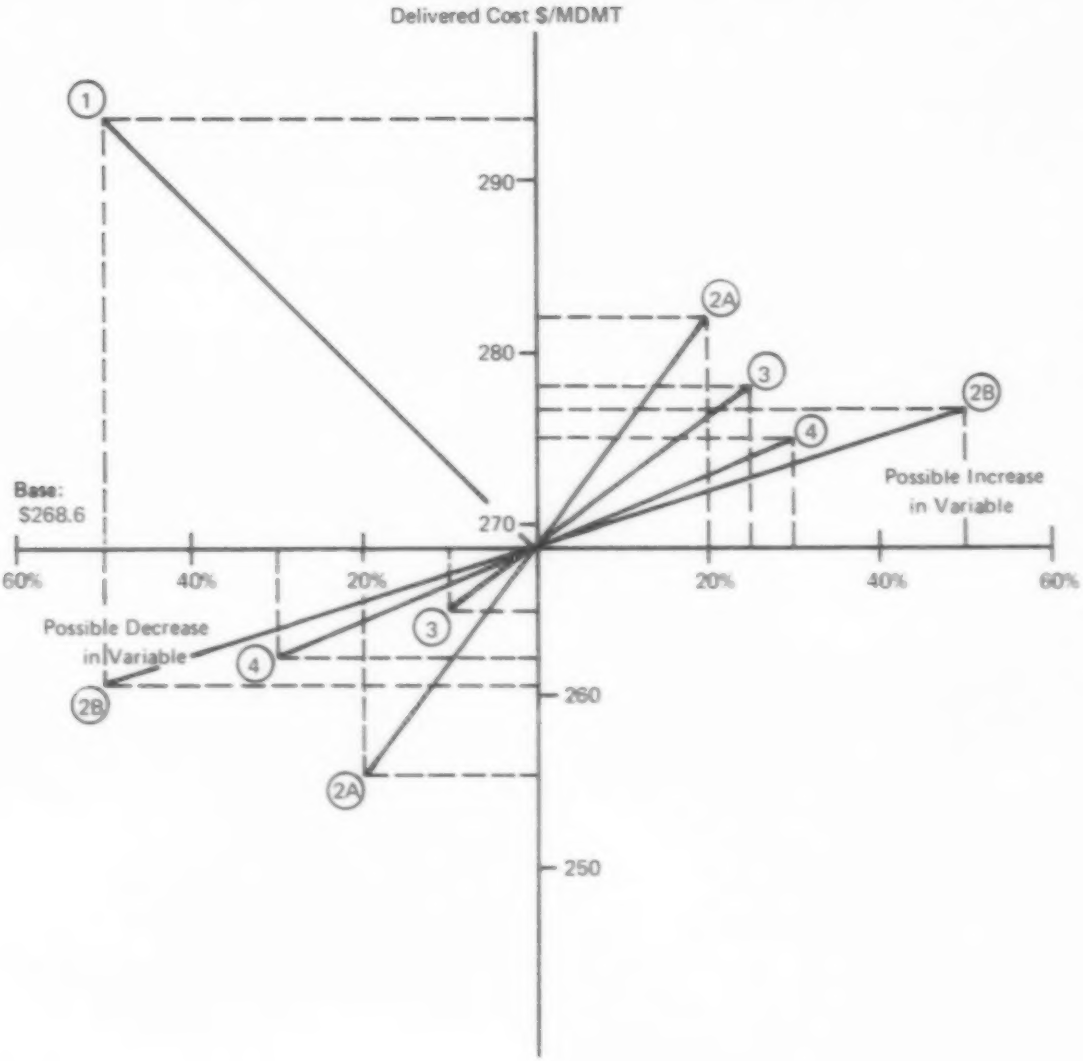
Figure IX-F-16

MATERIAL AND ENERGY BALANCE

(Basis: 1.0 MDMT uncoated paper)



0.23 ADMT SBK Slush Pulp
(208)
0.367 ADMT Groundwood Slush Pulp
(330)
(538)
Filler, Clay
(50)
Starch
(85)
0.359 MT No. 1 News as rec'd. @ 10% Moisture
(323)
Pulping & De-inking
(269)
(807)
Paper Making
(930)
1.0 MDMT @ 7% Moisture
17% Losses (54)
¼% Fiber Loss (2)
20% Filler Loss (10)
( ) Indicates BD kg
4400 kg Steam
Fossil Fuel
2.44 MM kcal
[9.7 MM Btu]
Power Boiler
To Process
Power Extracted 440 kWh
530 kWh
Purchased Power 90 kWh



KEY VARIABLES		Percent Variation	Best Guess	Possible High	Possible Low
1.	Scale of Operations, MTPD	+ 0, − 50	272	272	136
2. A	Delivered Cost of Fiber,* $/ADMT	+20, − 20	110	132	88
B		+50, − 50	45	68	23
3.	Fixed Capital, $ Million	+25, − 10	44	55	40
4.	Cost of Energy, $/MMBtu	+30, − 30	2.0	2.6	1.4

*2A–Virgin (Average Slush Pulp Cost), 2B–Secondary Fiber

FIGURE IX–F–17 SENSITIVITY OF THE MANUFACTURING COST OF UNCOATED GROUNDWOOD PRINTING PAPERS (BLENDED) TO KEY VARIABLES

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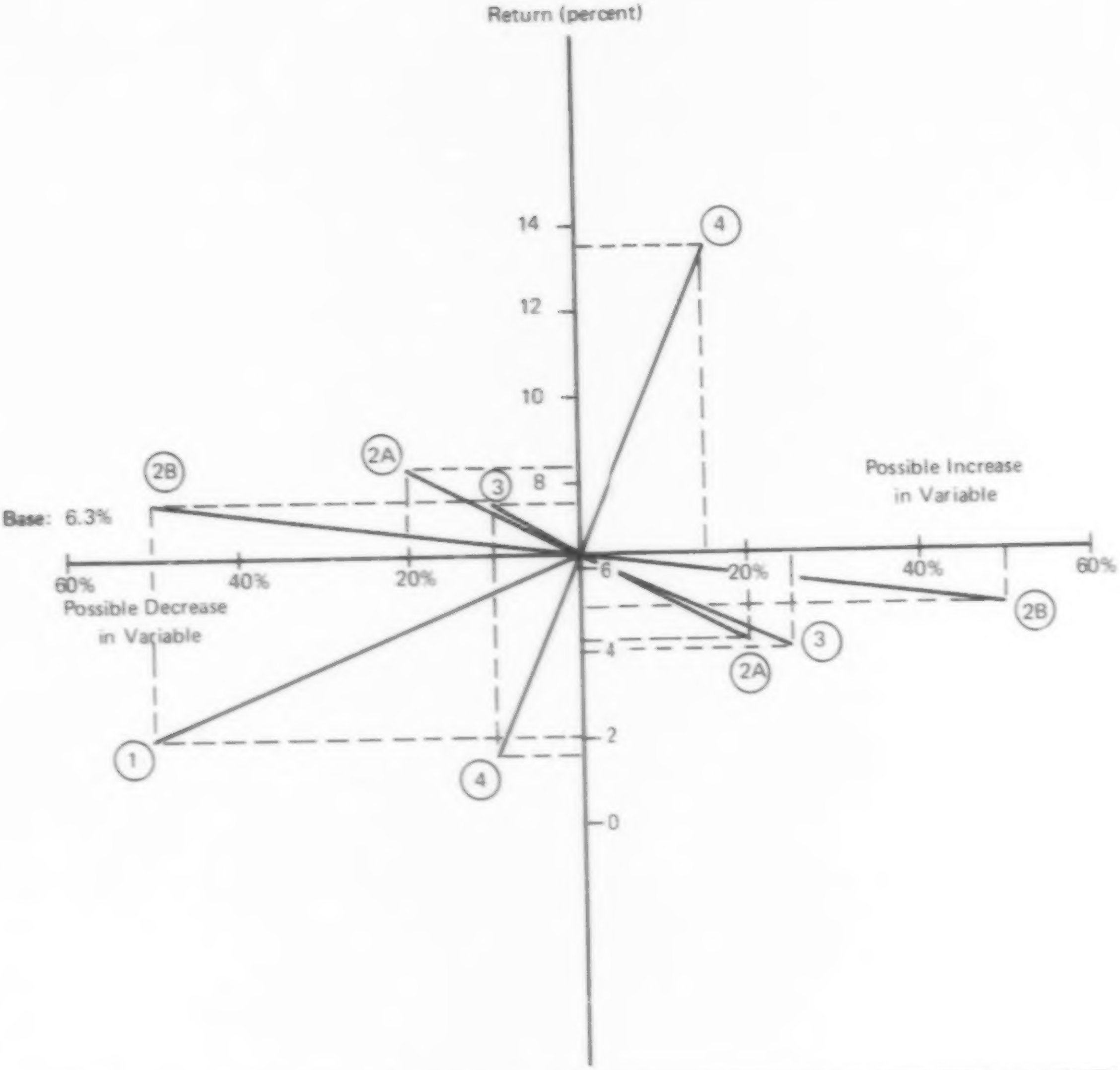


KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations,** MTPD	+ 0, −50	272	272	136
2. A Delivered Cost of Fiber,* $/ADMT	+20, −20	110	132	88
B	+50, −50	45	68	23
3. Fixed Capital,** $ Million	+25, −10	44	55	40
4. Selling Price, $/MDMT	+15, −10	310	357	279

*2A–Virgin (Avg. Slush Pulp Cost), 2B–Secondary Fiber

**Variation applies to papermaking operation only; allocated fixed capital for pulp manufacture is assumed constant at $15 million.

FIGURE IX–F–18 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF UNCOATED GROUNDWOOD PRINTING PAPERS (BLENDED) TO KEY VARIABLES

TABLE IX-F-15

ECONOMIC COMPARISON OF GROUNDWOOD PRINTING PAPER MANUFACTURED FROM VIRGIN VS. SECONDARY FIBER (NONINTEGRATED MILL)

Functional Group	Groundwood Papers	
Grade	Uncoated Printing Paper	
Basis Weight (g/m^2)	57 (35 lb/3000 sq ft)	
Fiber Furnish	100% Virgin	100% Secondary
Plant Size (MT/day)	136	136
Plant Location	Northeast	Northeast
Plant Specifics	Nonintegrated	Nonintegrated
Total Fixed Capital ($/Million)	27	33
Total Delivered Cost ($/MDMT)	360.3	324.6
Raw Materials ($/MT delivered)	180.4	109.8
Conversion ($/MT)	88.9	113.6
Capital-Related ($/MT)	46.0	56.2
Sales Cost (less freight)($/MT)	25.0	25.0
Freight In ($/MT)*	12.3	13.0
Freight Out ($/MT)	20.0	20.0
Selling Price ($ /MT)	310	280
Return on Fixed Capital, pre-tax (%)	- 8.4	- 6.1

*Not included in total delivered cost

TABLE IX-F-16

DESIGN BASIS

Functional Group	Groundwood Papers	Process	Groundwood Pulping plus SBK market pulp
Grade	Uncoated Printing Paper	Fiber Furnish	100% virgin (65% groundwood slush pulp, 35% market semi-bleached kraft)
Basis Weight	57 g/m^2 (35 lb/3000 sq ft)	Pulp Yield	n.a.
Production	136 MDMT/day; 45,000 MDMT/yr (rolls)	Mill Location	Northeast
Net Operating Days	330/yr	Boundary Limits	Papermaking integrated to groundwood pulping and purchased chemical market pulp

CAPITAL REQUIREMENTS*
($000)

Physical Plant	24,400	
Other Fixed Capital	2,400	
Total Fixed Capital**		27,000
Working Capital		4,000
Total Capital Required**		31,000

ENERGY REQUIREMENTS
(per MDMT)

Steam (kg)	Power (kWh)
4,300	610

OPERATING COST
($/MDMT)

Fiber Furnish	149.8	
Other Raw Materials	30.6	
Total Raw Materials Cost		180.4
Labor + Fringe @ 32% of Hourly Rate	27.8	
Supplies	20.6	
Energy	25.1	
Factory Overhead	15.4	
Total Conversion Costs		88.9
Capital-Related Costs		46.0
● Total Factory Operating Cost		315.3 ($286.0/MDST)
GS&A	25.0	
Freight Out	20.0	
Total Cost of Sales		45.0
● Total Delivered Cost		360.3 ($326.8/MDST)

*Totals may not add due to rounding.

**Does not include groundwood pulping capital of $5MM

TABLE IX-F-17

ESTIMATED OPERATING COST FOR THE MANUFACTURE OF UNCOATED PRINTING PAPER FROM 100% VIRGIN FIBER (NONINTEGRATED MILL)

Item	Unit	Unit Cost ($)	Units per MDMT	Operating Cost	
				$/MDMT	$000/Yr
RAW MATERIALS					
Slush Pulp					
Groundwood (65%)	ADMT	85.1	0.583	49.6	
Market Pulp					
Semi-bleached SW Kraft (35%)	ADMT	320	0.313	100.2	
Starch	kg	0.23	85	19.6	
Filler Clay	kg	0.09	50	4.5	
Chemicals					
Papermaking				4.5	
Other				2.0	
TOTAL RAW MATERIALS COST				180.4	
CONVERSION (less capital-related):					
Labor + fringe @ 32% hourly rate					
Direct	man-hr	6.3	1.8	11.3	
Indirect	man-hr	6.3	1.7	10.7	
Maintenance	man-hr	7.3	0.8	5.8	
Supplies					
Operating				7.2	
Packaging				4.0	
Maintenance				9.4	
Fuel					
Steam/Power Generation					
Residue Fuel	MM Btu				
Fossil Fuel	MM Btu	2.0	9.5	19.0	
Lime Reburning					
Fossil Fuel	MM Btu				
Power					
Extracted	kWh				
Purchased	kWh	0.01	610	6.1	
Factory Overhead @ 70% D.&I.L.				15.4	
TOTAL CONVERSION COST (less capital-related)				88.9	
CAPITAL-RELATED					
Depreciation @ 5.4% Fixed Capital				32.4	
Local taxes & ins. @ 2.5% PPC				13.6	
TOTAL CAPITAL-RELATED				46.0	
TOTAL FACTORY OPERATING COST				315.3	14,190
COST OF SALES					
General Administration				10.0	
Sales Expense				15.0	
Freight Out				20.0	
TOTAL COST OF SALES				45.0	
TOTAL DELIVERED COST (excl. interest on borrowed funds for fixed and working capital)				360.3	16,210

G. TISSUE AND OTHER MACHINE CREPED PAPER

1. Box Facial and Roll Toilet Tissue

a. Basis of Models

Three economic models have been prepared for the production of tissue paper from virgin fiber, secondary fiber, or a blend of both. This product is made with a range in quality to suit a variety of markets. The virgin and secondary products tend to be complementary rather than competitive; thus, we have selected a furnish for each model which does not attempt to give equal quality, and we have relfected quality differences in our selling price estimates.

For the virgin model, we have used a furnish of 50% each of bleached hardwood and softwood kraft pulp. For the secondary fiber model, we have established a pulp substitute deinking mixture of 40% IBM cards, 40% white ledger, and 20% No. 1 news. The blended model uses the pulp substitute deinking mixture for 33% of the furnish and the bleached hardwood and softwood kraft pulp mixture for the remaining 67%. We have estimated a selling price for the secondary fiber product discounted $100/MDMT from the virgin fiber price of $830/MDMT. We have discounted the blended fiber product $30/MDMT based on its secondary fiber content. The effect on return on capital of variations in these price differences can be determined from the sensitivity charts included for each model.

Virgin and secondary tissue products are produced in all regions of the country; the secondary fiber mills are located in metropolitan areas, with some concentration in the Northeast and North Central regions. We have chosen a Northeast location for all models to represent existing industry patterns and provide a common basis for comparison. Regional variations can be evaluated through use of the regional data previously presented (Table IX-C-1), in combination with the sensitivity charts for each model.

The virgin and blended models are sized at 136 MDMT/day to reflect a competitive scale of operations for a new tissue machine and converting installation. This machine would be integrated to a larger (730 ADMT/day) new pulping facility, with the excess pulp used elsewhere on site. (See Slush Pulp Cost, Section A.6.) Since the blended model represents the tissue portion of a larger total new mill installation it is indicative (although not directly) of the economics or the possible advantages of adding secondary fiber capacity in a situation where existing machine capacity might be expanded. (See Containerboard, Section E.1.a.) We have not attempted to determine how many machines have the potential for capacity expansion, nor have we idled pulp mill capacity when substituting secondary fiber in the blended model. The blended model provides the framework from which the potential costs and profitability of adding incremental capacity may be determined, given the specific conditions.

For secondary tissue we have selected a capacity of 64 MDMT/day, which is larger than typical of the existing industry. It is unlikely that a mill of this size could find sufficient fiber supply at competitive cost, but it represents a compromise between existing conditions of capacity and fiber availability, and a scale of operations large enough to be competitive with a virgin fiber machine. It is assumed that new sources of fiber would have to be developed to supply a mill of this scale.

b. Comparative Economics

Table IX-G-2 summarizes the total capital, delivered cost, and return on capital for the three tissue paper models. Total fixed capital for the virgin and blended models of $54 million and $50 million respectively includes papermaking, converting, deinking for the blended model, and an allocation of the capital costs for bleached kraft slush pulp production. On-site power generation is included for both by virtue of their integration to the larger pulping facility.

Total fixed capital for the secondary fiber model of $22 million is based on a single machine and includes pulp substitute deinking and tissue converting. It does not include on-site power generation, as the total steam requirements are below the minimum we have established for on-site power (see Section C.2.d.) The total capital requirements and investment per daily ton for secondary tissue are lower than for either the virgin or blended models. The implications of these differences will be discussed in the profitability analysis which follows.

The delivered cost for secondary tissue at $663.9/MDMT is higher than either the virgin product at $598.8 or the blended product at $628.2. There are several other disadvantages of this model. It has the highest raw material cost of the three models, because of the high cost of pulp substitute deinking grades relative to virgin fiber pulp. (The effect of fiber raw material cost on total delivered cost is shown in Figure IX-G-5.) In addition, the small scale of operation increases conversion and capital-related costs, and the fact that it is a nonintegrated operation with relative sensitivity to energy cost increases the costs of the secondary fiber model still further. However, if secondary fiber were at the low end of its cost range and the scale of operation were increased, the cost of this model would be lower than that of the blended model and close to the virgin fiber model.

The most attractive pre-tax return on fixed capital is that of the virgin fiber model (21%). As indicated by the sensitivity charts, a low-cost source of secondary fiber and elimination of the selling price differential would make the blended model competitive. The same factors plus increased scale of operations would be required to make the virgin fiber model competitive. The key to making both the blended and secondary models more viable is an increase in secondary pulp substitute fiber availability at a relatively low and stable cost.

We have included an operating cost estimate only for one additional model, a nonintegrated virgin fiber mill using market pulp as the fiber raw material. Table IX-G-13 compares this model with the 100% secondary fiber model. The costs for the nonintegrated virgin fiber model have been developed by taking the same capacity as the secondary fiber model and substituting market pulp for secondary fiber, with corresponding reductions in conversion and capital costs.

Thus, the nonintegrated virgin fiber model represents a new single-machine installation. Since this is a hypothetical case not directly representative of either the existing industry or probable capacity expansions, we consider it unrealistic to do the related sensitivity and profitability calculations. Our intent in including it is to provide a comparison on an equivalent basis of high-grade pulp substitute deinking waste papers and market pulp as alternative fiber sources for nonintegrated papermaking.

The nonintegrated virgin fiber model does provide a framework for estimating actual mill costs, but one must keep in mind that the nonintegrated paper industry has no new or recent installations, and that its production is not accurately characterized by a single-machine operation.

The total delivered cost of $812.3/MDMT and the raw material cost of $450.9/MDMT for the nonintegrated virgin fiber model compare with secondary fiber model costs of $663.9 and $357.4 respectively. These differences are due to fiber source alone, and would also exist at other levels of actual operating cost if the costs of conversion, capital, and sales differed from those of our models. The fiber cost differences readily explain the high cost and extensive use of high-grade pulp substitute deinking secondary fiber sources.

Accordingly, the existing nonintegrated paper mills could provide a ready market, even at reduced product selling prices, if new sources of these secondary fiber grades could be developed. Utilization would remain high at much greater secondary fiber tonnages than presently generated, so long as market pulp prices were at a level where our comparison is valid.

TABLE IX-G-1

ECONOMIC COMPARISON OF TISSUE MANUFACTURE TO JUMBO ROLLS

Functional Group	Tissue and Towelling		
Grade	Jumbo Rolls, Facial and Toilet		
Basis Weight	N.A.		
Fiber Furnish	100% Virgin	100% Secondary	67% Virgin 33% Secondary
Plant Size (MT/DAY)	136	64	136
Plant Location	Northeast	Northeast	Northeast
Plant Specifics	Integrated	Non-Integrated	Integrated
Total Fixed Capital ($ Million)	22*	16**	25**
($000/Daily Ton)	162	250	183
Total Factory Cost ($/MDMT)	257.3	392.9	288.7
Raw Materials ($/MT, delivered)	169.6	215.2	184.4
Conversion ($/MT)	51.1	119.0	62.2
Capital-Related ($/MT)	36.7	58.6	42.0
Sales Cost (less freight) ($/MT)	-	-	-
Freight in ($/MT Product)***	19.8	22.0	20.1
Freight out ($/MT Product)	-	-	-
Selling Price	-	-	-
Return on Fixed Capital, pre-tax (%)	-	-	-

*Papermaking only
**Papermaking and De-inking only
***Not included in total delivered cost

TABLE IX-G-2

ECONOMIC COMPARISON OF CONVERTED TISSUE PRODUCTS

Functional Group	Tissue & Towelling		
Grade	Box Facial and Roll Toilet Tissue		
Basis Weight	N.A.		
Fiber Furnish	100% Virgin	100% Secondary	67% Virgin 33% Secondary
Plant Size (MT/DAY)	150	70	150
Plant Location	Northeast	Northeast	Northeast
Plant Specifics	Integrated	Non-Integrated	Integrated
Total Fixed Capital*($ Million)	54	22	50
($000/Daily Ton)	360	314	333
Total Delivered Cost ($/MDMT)	598.8	663.9	628.2
Raw Materials**($/MT, delivered)	231.2	357.4	260.5
Conversion ($/MT)	129.4	129.4	129.4
Capital-Related ($/MT)	18.6	20.0	18.6
Sales Cost (less freight) ($/MT)	153.6	98.5	153.6
Freight in ($/MT Product)***	18.4	20.5	18.7
Freight out ($/MT Product)	66.0	58.4	66.0
Selling Price ($/MDMT)	830	730	800
Return on Fixed Capital, pre-tax (%)	21.0	6.9	16.8

*Includes pulping, papermaking, and converting
**Included total factory cost, jumbo rolls
***Not included in total delivered cost

TABLE IX-G-3

DESIGN BASIS

Functional Group	Tissue & Other Machine Creped Paper	Net Operating Days	330/yr
		Process	Integrated to bl. kraft
Grade	60% boxed facial tissue, 40% roll toilet tissue	Fiber Furnish	100% virgin bl. kraft slush pulp (50% SW, 50% HW)
Basis Weight	n.a.	Pulp Yield	n.a.
Production			
Jumbo Rolls	136 MDMT/day; 45,000 MDMT/yr	Mill Location	Northeast
Converted & Pkgd.	150 MDMT/day; 49,500 MDMT/yr	Boundary Limits	Transfer of slush pulp through production of converted tissue products

CAPITAL REQUIREMENTS*
($000)

	Jumbo Roll	Converted & Pkgd.	Total
Physical Plant	20,000	31,300	51,300
Other Fixed Capital	2,000	3,100	5,100
Total Fixed Capital	22,000	34,000	56,000
Working Capital	2,000	6,000	8,000
Total Capital Required	24,000	40,000	64,000

ENERGY REQUIREMENTS
(per MDMT)

	Steam (kg)	Power (kWh)
Jumbo Rolls		
Stock Preparation	--	150
Paper Making	2,000	150
Effluent Treatment	--	20
Misc. & Auxiliaries	400	20
	2,400	340
Conversion & Packaging		
Converting Misc. & Auxiliaries	1,000	30
Total	3,400	370

*Totals may not add due to rounding.

TABLE IX-G-3 (Cont'd.)

OPERATING COST*

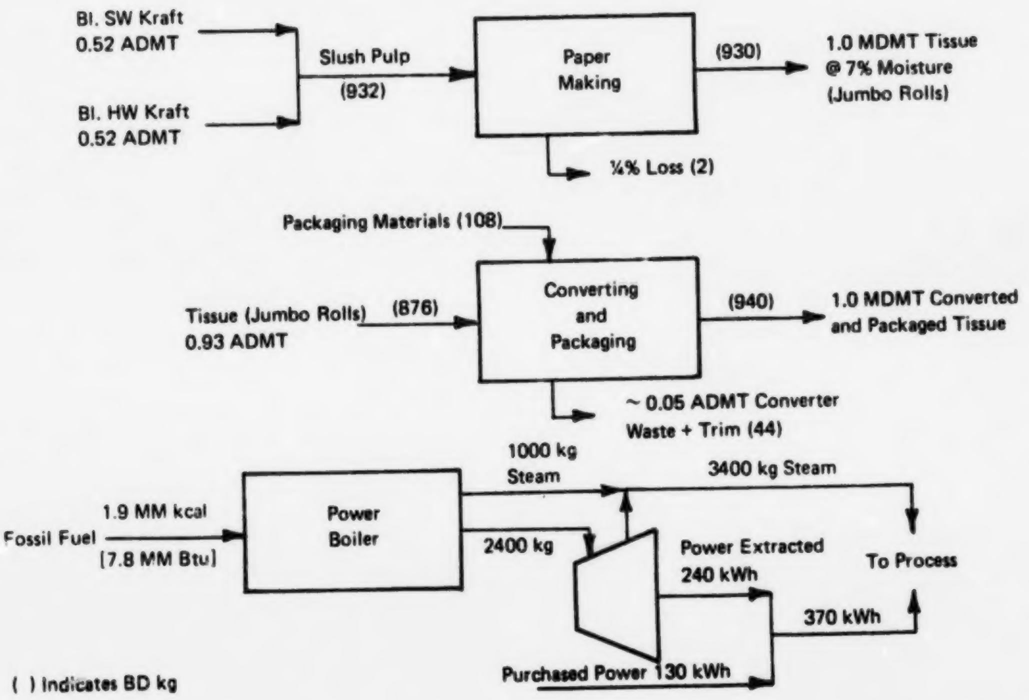
	Jumbo Rolls ($/MDMT)		Converting and Packaging ($/MDMT)**	
Fiber Furnish	161.1		231.2	
Other Raw Materials	8.5		n.a	
Total Raw Materials Cost		169.6		231.2
Labor + Fringe @ 32% of Hourly Rate	19.6		34.2	
Supplies	10.5		81.4	
Energy	13.1		5.2	
Factory Overhead	7.8		8.5	
Total Conversion Costs		51.1		129.4
Capital-Related Costs		36.7		18.6
• **Total Factory Operating Cost**		257.3 ($233.4/MDST)		379.2
GS&A			153.6	
Freight Out			66.0	
Total Cost of Sales				219.6
• **Total Delivered Cost**				598.8 ($543.2/MDST)

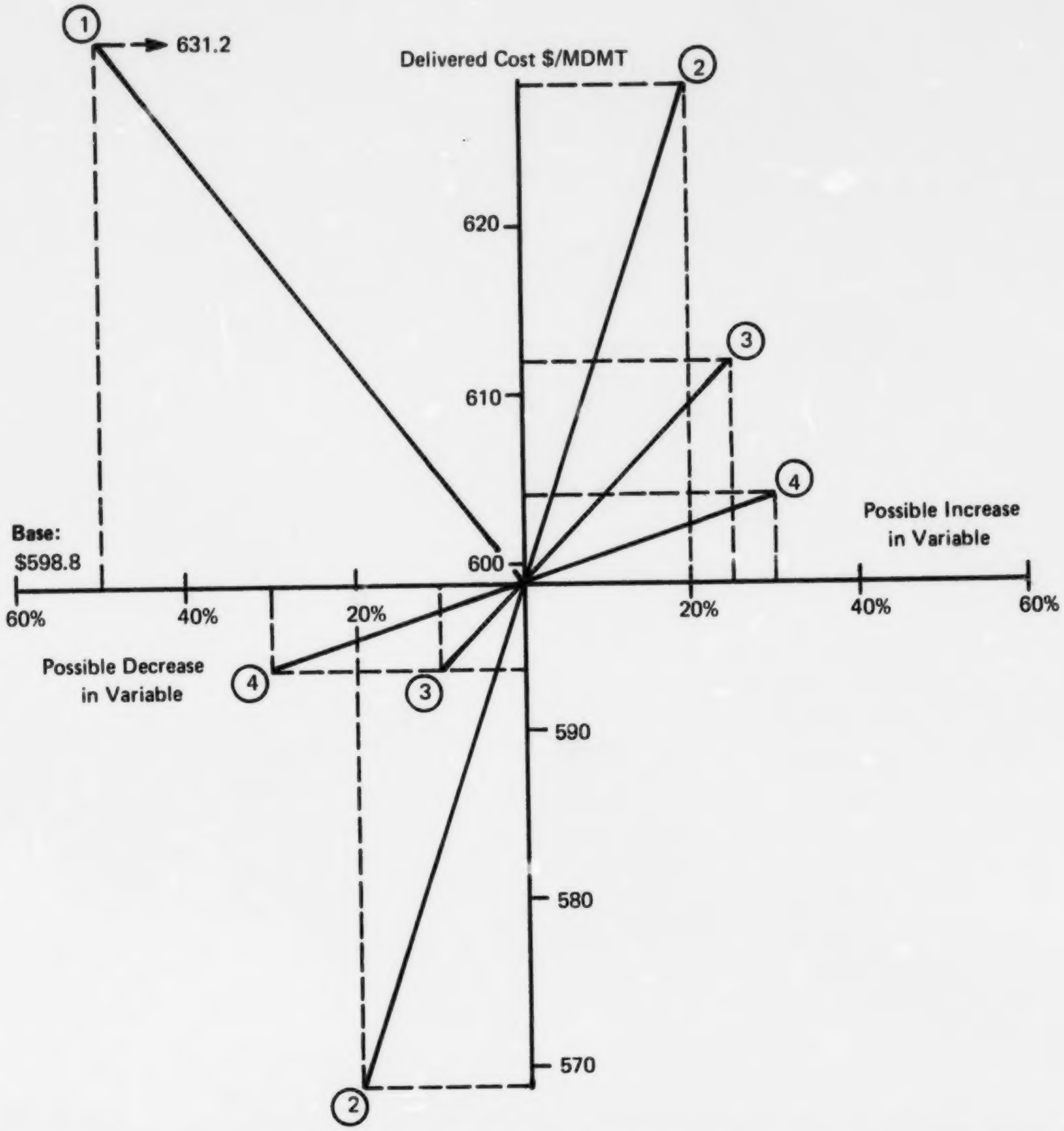
**Based on gross weight of converted tissue products, including packaging.

FIGURE IX-G-1

MATERIAL AND ENERGY BALANCE

(Basis: 1 machine-dry metric ton of product)


Bl. SW Kraft
0.52 ADMT
Bl. HW Kraft
0.52 ADMT
Slush Pulp
(932)
Paper Making
(930)
1.0 MDMT Tissue @ 7% Moisture (Jumbo Rolls)
¼% Loss (2)
Packaging Materials (108)
Tissue (Jumbo Rolls)
0.93 ADMT
(876)
Converting and Packaging
(940)
1.0 MDMT Converted and Packaged Tissue
~ 0.05 ADMT Converter Waste + Trim (44)
Fossil Fuel
1.9 MM kcal
[7.8 MM Btu]
Power Boiler
1000 kg Steam
2400 kg
3400 kg Steam
Power Extracted
240 kWh
To Process
370 kWh
Purchased Power 130 kWh
( ) Indicates BD kg



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operation, MTPD	+ 0, −50	150	150	75
2. Delivered Cost of Fiber,* $/ADMT	+20, −20	155	186	124
3. Fixed Capital, $ Million	+25, −10	34	43	31
4. Cost of Energy, $/MMBtu	+30, −30	2.0	2.6	1.4

*Average Slush Pulp Cost

FIGURE IX–G–2 SENSITIVITY OF THE MANUFACTURING COST OF BOX FACIAL AND ROLL TOILET TISSUE (VIRGIN) TO KEY VARIABLES

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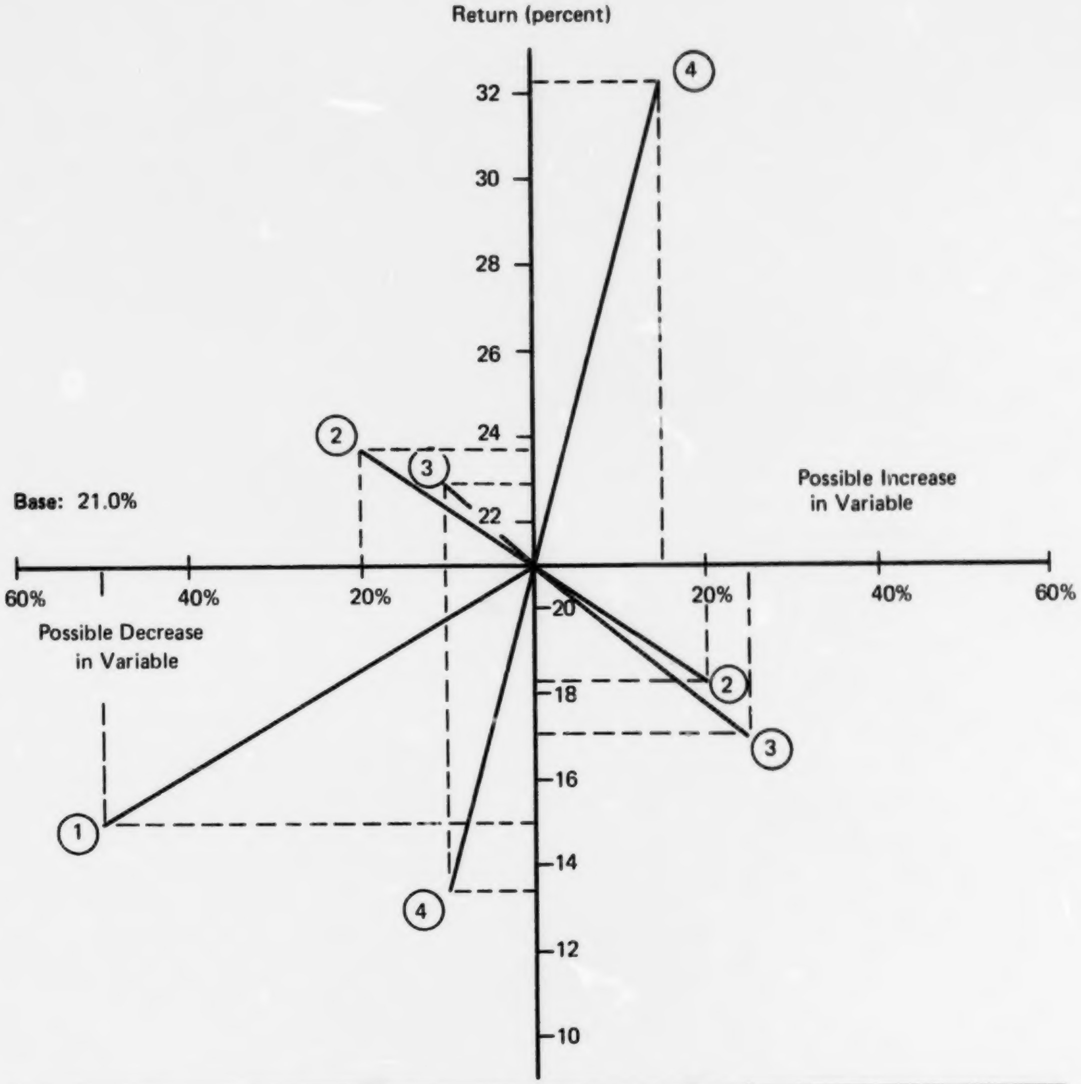


KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations,** MTPD	+0, –50	150	150	75
2. Delivered Cost of Fiber,* $/ADMT	+20, –20	155	186	124
3. Fixed Capital,** $ Million	+25, –10	34	43	31
4. Selling Price, $/MDMT	+15, –10	830	955	747

*Average Slush Pulp Cost

**Variation applies to papermaking operation only; allocated fixed capital for pulp manufacture is assumed constant at $20 million.

FIGURE IX–G–3 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF BOX FACIAL AND ROLL TOILET TISSUE (VIRGIN) TO KEY VARIABLES

TABLE IX-G-6

DESIGN BASIS

Functional Group	Tissue & Other Machine Creped Paper	Net Operating Days	330/yr
Grade	60% boxed facial tissue, 40% roll toilet tissue	Process Fiber Furnish	S/F pulping and de-inking 100% S/F (40% IBM card stock, 40% ledger, 20% No. 1 news)
Basis Weight	n.a.	Pulp Yield	n.a.
Production			
Jumbo Rolls	64 MDMT/day; 21,000 MDMT/yr	Mill Location Boundary Limits	Northeast S/F preparation through production of converted tissue products
Converted & Pkgd.	70 MDMT/day; 23,000 MDMT/yr		

CAPITAL REQUIREMENTS*
($000)

	Jumbo Roll		Convert. & Pkg.		Total	
Physical Plant	14,700		5,700		20,400	
Other Fixed Capital	1,500		600		2,100	
Total Fixed Capital		16,000		6,000		22,000
Working Capital		1,000		3,000		4,000
Total Capital Required		17,000		9,000		26,000

ENERGY REQUIREMENTS
(per MDMT)

	Steam (kg)	Power (kWh)
Jumbo Rolls		
De-inking	500	300
Stock Preparation	–	150
Paper Making	2,000	150
Effluent Treatment	–	35
Misc. & Auxiliaries	500	35
Conversion & Packaging		
Converting Misc. & Auxiliaries	1,000	30
Total	4,000	700

*Totals may not add due to rounding.

TABLE IX-G-6 (Cont'd.)

OPERATING COST*

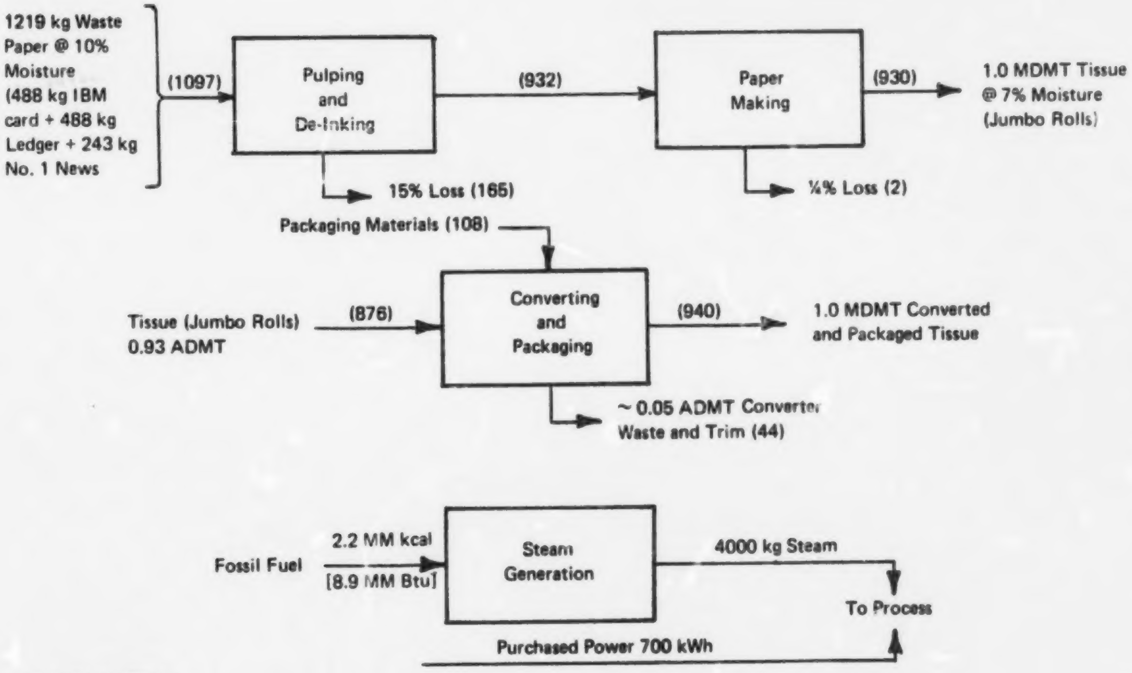
	Jumbo Rolls ($/MDMT)		Converting and Packaging ($/MDMT)**	
Fiber Furnish	199.8		357.4	
Other Raw Materials	15.4		–	
Total Raw Materials Cost		215.2		357.4
Labor + Fringe @ 32% of Hourly Rate	48.1		34.2	
Supplies	16.1		81.4	
Energy	27.2		5.2	
Factory Overhead	27.6		8.5	
Total Conversion Costs		119.0		129.4
Capital-Related Costs		58.6		20.0
● **Total Factory Operating Cost**		392.8 ($356.3/MDST)		507.0
GS&A			98.5	
Freight Out			58.4	
Total Cost of Sales				157.0
● **Total Delivered Cost**				663.9 ($602.3/MDST)

**Based on gross weight of converted tissue products, including packaging.

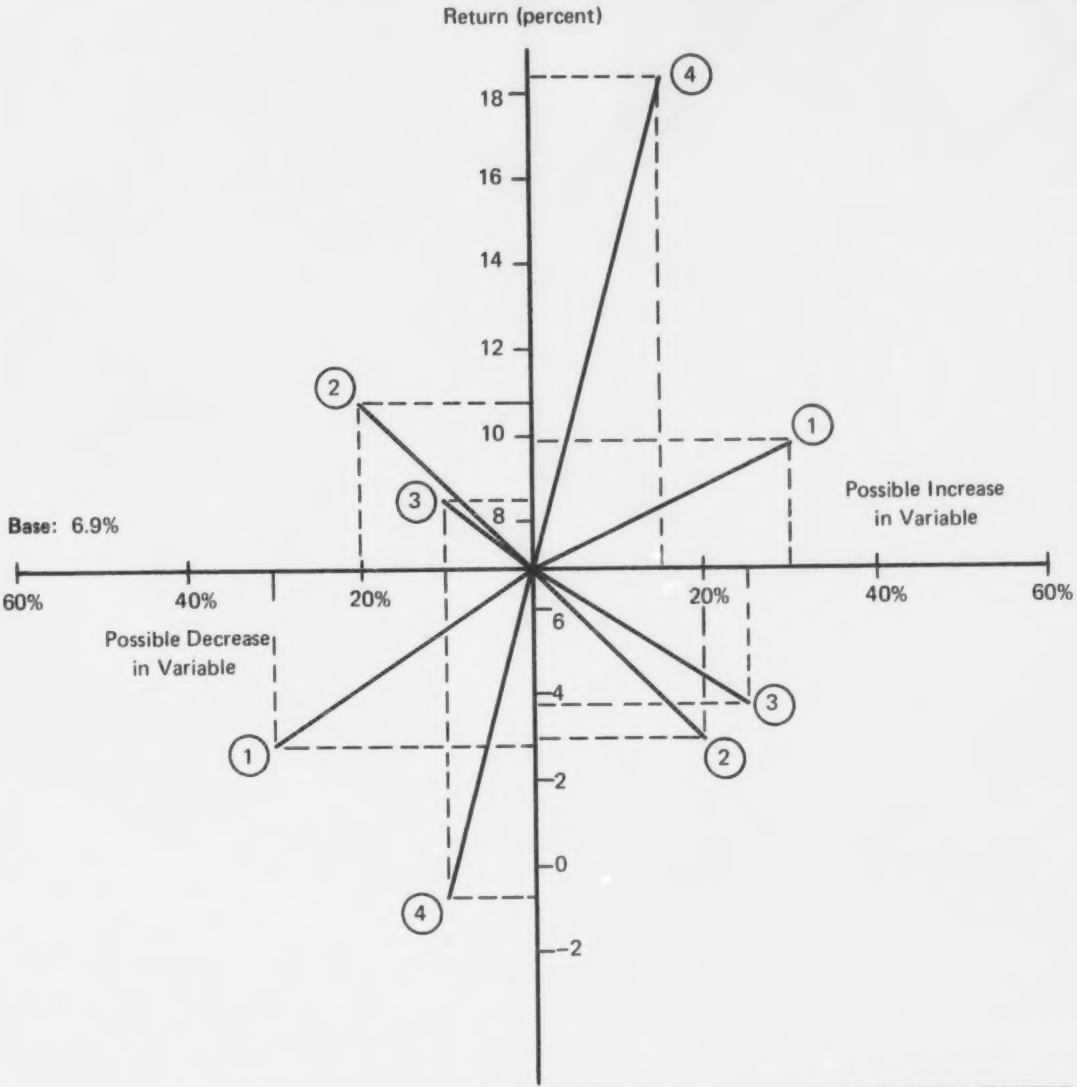
FIGURE IX-G-4

MATERIAL AND ENERGY BALANCE

(Basis: 1 machine-dry metric ton of product)


1219 kg Waste Paper @ 10% Moisture (488 kg IBM card + 488 kg Ledger + 243 kg No. 1 News
(1097)
Pulping and De-Inking
(932)
Paper Making
(930)
1.0 MDMT Tissue @ 7% Moisture (Jumbo Rolls)
15% Loss (165)
¼% Loss (2)
Packaging Materials (108)
Tissue (Jumbo Rolls) 0.93 ADMT
(876)
Converting and Packaging
(940)
1.0 MDMT Converted and Packaged Tissue
~ 0.05 ADMT Converte
Waste and Trim (44)
Fossil Fuel
2.2 MM kcal
[8.9 MM Btu]
Steam Generation
4000 kg Steam
To Process
Purchased Power 700 kWh

( ) Indicates BD kg



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+30, –30	70	91	49
2. Delivered Cost of Fiber,* $/ADMT	+20, –20	164	197	131
3. Fixed Capital, $ Million	+25, –10	22	28	20
4. Selling Price, $/MDMT	+15, –10	730	840	657

*Composite Average Secondary Fiber Cost

FIGURE IX–G–6 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF BOX FACIAL AND ROLL TOILET TISSUE (SECONDARY) TO KEY VARIABLES

Pages IX-G-14, IX-G-15 and IX-G-16 are blank.

TABLE IX-G-9

DESIGN BASIS

Functional Group	Tissue & Other Machine Creped Paper	Net Operating Days	330/yr
		Process	Integrated to bl. kraft
Grade	60% boxed facial tissue, 40% roll toilet tissue	Fiber Furnish	67% virgin bl. kraft slush pulp (50% SW, 50% HW), 33% S/F
Basis Weight	n.a.	Pulp Yield	n.a.
Production			
Jumbo Rolls	136 MDMT/day; 45,000 MDMT/yr	Mill Location	Northeast
Converted & Pkgd.	150 MDMT/day; 49,500 MDMT/yr	Boundary Limits	Transfer of slush pulp and S/F preparation through production of converted tissue products

CAPITAL REQUIREMENTS*
($000)

	Jumbo Roll		Converted & Pkgd.		Total	
Physical Plant	22,900		11,300		34,200	
Other Fixed Capital	2,200		1,100		3,300	
Total Fixed Capital		25,000		12,000		37,000
Working Capital		2,000		6,000		8,000
Total Capital Required		27,000		18,000		45,000

ENERGY REQUIREMENTS
(per MDMT)

	Steam (kg)	Power (kWh)
Jumbo Rolls		
De-inking	175	100
Stock Preparation	--	150
Paper Making	2,000	150
Effluent Treatment	--	35
Misc. & Auxiliaries	425	35
	2,600	470
Conversion & Packaging		
Converting } Misc. & Auxiliaries }	1,000	30
Total	3,600	500

*Totals may not add due to rounding.

TABLE IX-G-9 (Cont'd.)

OPERATING COST

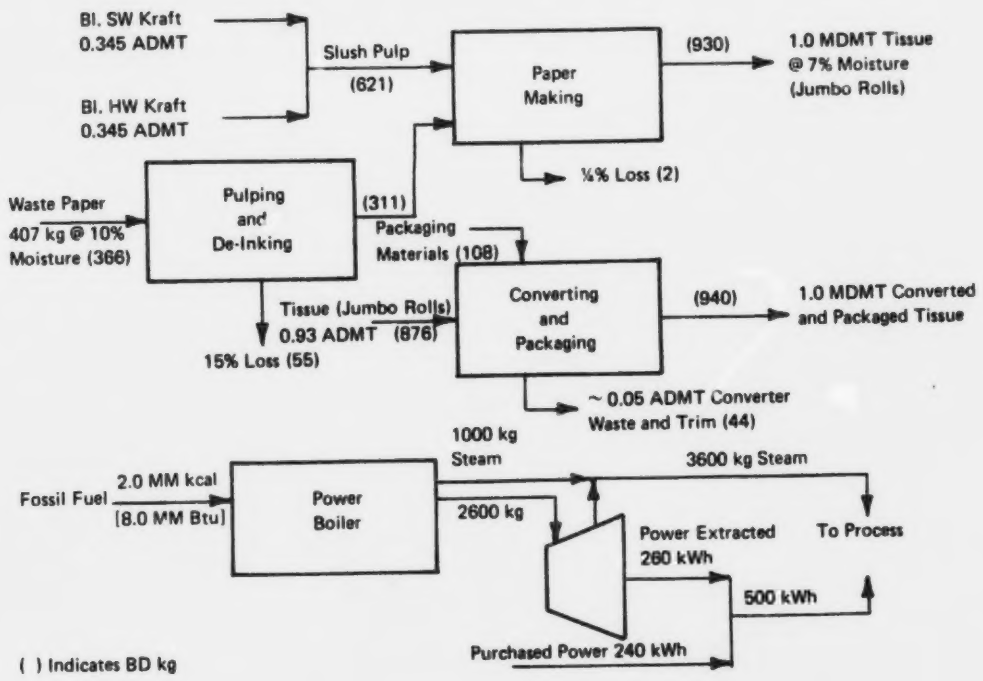
	Jumbo Rolls ($/MDMT)		Converting and Packaging ($/MDMT)**	
Fiber Furnish	173.7		260.5	
Other Raw Materials	10.8		n.a.	
Total Raw Materials Cost		184.4		260.5
Labor + Fringe @ 32% of Hourly Rate	24.7		34.2	
Supplies	11.7		81.4	
Energy	15.8		5.2	
Factory Overhead	10.2		8.5	
Total Conversion Costs		62.2		129.4
Capital-Related Costs		42.0		18.6
• **Total Factory Operating Cost**		288.7 ($261.9/MDST)		408.5
GS&A			153.6	
Freight Out			66.0	
Total Cost of Sales				219.6
• **Total Delivered Cost**				628.2 ($569.9/MDST)

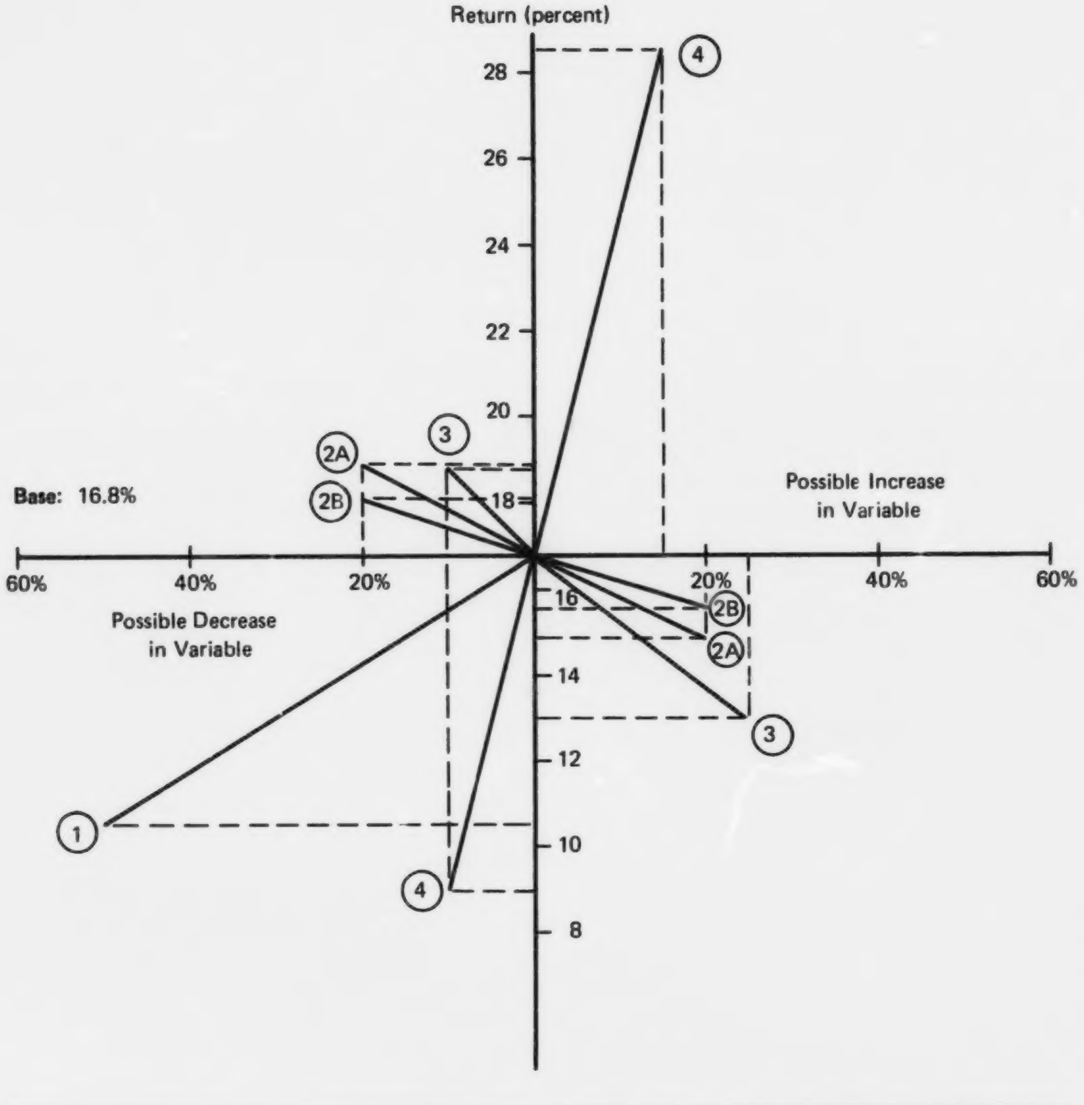
**Based on gross weight of converted tissue products, including packaging.

FIGURE IX-G-7

MATERIAL AND ENERGY BALANCE

(Basis: 1 machine-dry metric ton of product)


Bl. SW Kraft
0.345 ADMT
Bl. HW Kraft
0.345 ADMT
Slush Pulp
(621)
Paper Making
(930)
1.0 MDMT Tissue
@ 7% Moisture
(Jumbo Rolls)
¼% Loss (2)
Waste Paper
407 kg @ 10%
Moisture (366)
Pulping and De-Inking
(311)
Packaging
Materials (108)
Tissue (Jumbo Rolls)
0.93 ADMT (876)
15% Loss (55)
Converting and Packaging
(940)
1.0 MDMT Converted
and Packaged Tissue
~ 0.05 ADMT Converter
Waste and Trim (44)
1000 kg
Steam
3600 kg Steam
Fossil Fuel
2.0 MM kcal
[8.0 MM Btu]
Power Boiler
2600 kg
Power Extracted
260 kWh
To Process
500 kWh
Purchased Power 240 kWh
( ) Indicates BD kg



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations,** MTPD	+ 0, −50	150	150	75
2. A B Delivered Cost of Fiber,* $/ADMT	+20, −20	155 164	186 197	124 131
3. Fixed Capital,** $ Million	+25, −10	37	46	33
4. Selling Price, $/MDMT	+15, −10	800	920	720

*2A – Virgin (avg. slush pulp cost), 2B – Secondary Fiber (avg.)

**Variation applies to papermaking operation only; allocated fixed capital for pulp manufacture is assumed constant at $13 million.

FIGURE IX–G–9 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF BOX FACIAL AND ROLL TOILET TISSUE (BLENDED) TO KEY VARIABLES

Pages IX-G.20, IX-G.21 and (IX-G-23) IX-G-22 are blank.

TABLE IX-G-12

ECONOMIC COMPARISON OF JUMBO ROLL MANUFACTURE FROM VIRGIN VS. SECONDARY FIBER (NON-INTEGRATED MILL)

Functional Group	Tissue & Towelling	
Grade	Jumbo Rolls, Facial & Toilet	
Basis Weight	Not Applicable	
Fiber Furnish	100% Virgin	100% Secondary
Plant Size (MT/Day)	64	64
Plant Location	Northeast	Northeast
Plant Specifics	Nonintegrated	Nonintegrated
Total Fixed Capital	13	16
Total Delivered Cost ($/MDMT)	493.1	392.9
Raw Materials ($/MT del'd)	343.9	215.2
Conversion ($/MT)	101.5	119.0
Capital Related ($/MT)	47.7	58.6
Sales Cost (less freight) ($/MT)	-	-
Freight In ($/MT) *	22.9	22.0
Freight Out ($/MT)	-	-
Selling Price ($/MT)	-	-
Return on Fixed Capital, Pre-tax (%)	-	-

*Not included in total delivered cost

TABLE IX-G-13

ECONOMIC COMPARISON OF CONVERTED TISSUE PRODUCTS FROM VIRGIN VS. SECONDARY FIBER (NONINTEGRATED MILL)

Functional Group	Tissue & Towelling	
Grade	Box Facial & Roll Toilet Tissue	
Basis Weight	Not Applicable	
Fiber Furnish	100% Virgin	100% Secondary
Plant Size (MT/day)	70	70
Plant Location	Northeast	Northeast
Plant Specifics	Nonintegrated	Nonintegrated
Total Fixed Capital *($Million)	19	22
Total Delivered Cost ($/MDMT)	812.3	663.9
Raw Materials** ($/MT Delivered)	450.9	357.4
Conversion ($/MT)	129.4	129.4
Capital Related ($/MT)	20.0	20.0
Sales Cost (less freight)($/MT)	153.6	98.5
Freight in ($/MT) ***	21.3	20.5
Freight Out ($/MT)	58.4	58.4
Selling Price ($/MT)	830	730
Return on Fixed Capital, pre-tax (%)	2.1	6.9

*Includes papermaking and converting
** Includes total factory cost, jumbo rolls
***Not included in total delivered cost

TABLE IX-G-14

DESIGN BASIS

Functional Group	Tissue & Towelling	Process	Market Pulp
Grade	60% Box Facial; 40% roll toilet tissue	Fiber Furnish	100% virgin (market pulp)
Basis Weight	n.a.	Pulp Yield	n.a.
Production	70 MDMT/day; 23,000 MDMT/yr	Mill Location	Northeast
Net Operating Days	330/yr	Boundary Limits	Nonintegrated; purchased market pulp through converting

CAPITAL REQUIREMENTS*

	Jumbo Rolls	Conv.	Total
Physical Plant	12,000	5,700	17,700
Other Fixed Capital	1,200	600	1,800
Total Fixed Capital	13,000	6,000	19,000
Working Capital			4,000
Total Capital Required			23,000

ENERGY REQUIREMENTS (per MDMT)

	Steam (kg)	Power (kWh)
Jumbo Rolls	2,500	520
Converting	1,000	30

OPERATING COST ($/MDMT)

Fiber Furnish	335.4	
Other Raw Materials	8.5	
Total Raw Materials Cost		343.9
Labor + Fringe @ 32% of Hourly Rate	40.9	
Supplies	13.6	
Energy	22.6	
Factory Overhead	24.0	
Total Conversion Costs		101.1
Capital-Related Costs		47.7
● Total Factory Operating Cost		492.7 ($446.8/ MDST)

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*Totals may not add due to rounding.

H. FOLDING BOXBOARD

1. Recycled vs Virgin Fiberboard

a. Basis of Models

Two economic models have been prepared to compare the costs of using secondary and virgin fiber in this functional group. The secondary fiber example is that for an 18-point (about 68 lb/MSF) clay-coated recycled board; the virgin fiber model uses a 16-point (about 60 lb/MSF) solid bleached sulfate (SBS) board. These two dissimilar weights and caliper products were selected because they produce about the same package stiffness, which is one of the principal sales criteria.

In the case of the 18-point clay-coated board, we have chosen 100% recycled fiber furnish, which is typical for this application. The cost and board performance comparisons are predicated on the use of one of the new multiformer board machines rather than a cylinder machine, which is more prevalent in the industry; this was done because of the demonstrated superior product quality from the newer forming devices. (See Section VIII, Substitutability of Virgin with Secondary Fiber.) The multiformer is assumed to have on-machine coating facilities and to produce 360 MDMT/day, which is substantially more than any existing operation of this type. While it is technically feasible to obtain this production on a single machine, in practice the economic feasibility of using one or two machines depends on the product mix (i.e., the range of grade variation and duration of machine "runs").

Note that the recycled board model includes facilities for on-site power generation. This also is typical of existing operations and reflects our judgment that, in light of existing energy costs, new installations of this size would find it economically advantageous to invest the additional fixed capital to realize a savings in operating costs.

A North Central location was chosen for the recycled board example as typical of existing industry patterns and potential growth opportunities. Regional cost variations can be determined by use of the regional data previously presented (Table IX-C-1) and the sensitivity charts for this model.

The virgin fiber mill is sized at 450 MDMT/day--again, significantly larger than many existing operations but typical for a new installation. The model assumes typical industry patterns in which the board machine is part of a larger integrated pulp and paper/paperboard manufacturing facility. Consistent with industry practice, a Southeast location has been chosen as typical of existing industry patterns and potential growth opportunities.

When comparing the cost of these examples, note that in many applications these products are complementary and not in mutual competition. For example, end-use applications requiring a caliper greater than 18-80 points typically use recycled board, while those requiring less than 12-14 points typically use SBS board. Direct competition occurs primarily in applications that call for calipers of 14-18 points.

In addition to adjustments made for the greater yield per equivalent package stiffness obtained with SBS board, this product has other cost advantages in the automatic packaging operation that typically follows. These additional cost advantages are not reflected in our economic comparison, which is based upon the manufacture of rolls.

b. Comparative Economics

Table IX-H-1 summarizes the capital, operating costs, and profitability of the selected examples. Total fixed capital for the 18-point clay-coated recycled board model is \$48 million (equivalent to \$133,000/daily ton), which includes the cost of on-site power generation facilities as well as process equipment. The investment is substantially less than for virgin fiber board at \$108 million and \$240,000/daily ton respectively. (The \$108 million includes \$39 million for the board mill plus \$69 million allocated investment in the pulp mill.)

The delivered cost of the 18-point clay-coated (\$203/ton) is significantly less than that of SBS board (\$249/ton). However, these are two distinctly different materials with dissimilar selling prices. During the second quarter of 1974, the period upon which this cost comparison is based, the selling price for 18-point clay-coated was \$240/ton; that for SBS board was \$330/ton. This difference more than offset the higher cost of the SBS board, making the calculated ROI more favorable for the virgin fiber board than the recycled product. The cost of waste paper is once again one of the key variables. The actual fluctuation in waste paper prices that occurred within the 1973-1974 period would have changed the calculated ROI from a low of about 3% (when prices increased sharply in 1973 to early 1974) to a high of 15% (when prices dropped drastically in the third quarter of 1974).

Since SBS board has a higher package stiffness per unit weight than recycled board, their costs can be compared on the basis of equivalent weight rather than actual weight. Thus, the converter has the option of buying a ton of recycled board for \$240 or 0.88 ton of SBS for \$290 to obtain the equivalent yield while maintaining the same package stiffness. The apparent cost advantage is still with the recycled product; however, because of the better appearance of SBS board and the savings that accrue in the box plant when it is used, it has been able to compete successfully in spite of its higher price.

TABLE IX-H-1

Economic Comparison of Folding Boxboard Manufacture

Functional Group	Folding Boxboard	
Grade	18-point clay coated	SBS Board, Uncoated
Basis Weight (g/m^2)	N.A.	293
Fiber Furnish	100% Secondary	100% Virgin
Plant Size (MT/DAY)	360	450
Plant Location	North Central	Southeast
Plant Specifics	Non-Integrated	Integrated
Total Fixed Capital* ($ Million)	48	108
($000/Daily Ton)	133	240
Total Delivered Cost ($/MDMT)	202.6	248.8
Raw Materials ($/MT, delivered)	78.0	148.5
Conversion ($/MT)	66.7	37.6
Capital-Related ($/MT)	31.0	19.8
Sales Cost (less freight) ($/MT)	11.9	13.0
Freight in ($/MT Product)**	13.1	17.0
Freight out ($/MT Product)	15.0	30.0
Selling Price ($/MDMT)	240	330
Return on Fixed Capital,* pre-tax (%)	9.3	11.3

* Including pulping

** Not included in total delivered cost

TABLE IX-H-2
DESIGN BASIS

Functional Group	Folding Boxboard	Process	S/F pulping
Grade	18-pt clay coated (50% sheet, 50% roll)	Fiber Furnish	100% S/F (Top liner: ledger; filler liner: 90% news, 20% OCC)
Basis Weight	n.a.	Pulp Yield	n.a.
Production	360 MDMT/day; 119,000 MDMT/yr	Mill Location	North Central
Net Operating Days	330/yr	Boundary Limits	Preparation of secondary fiber to board making

CAPITAL REQUIREMENTS*
($000)

Physical Plant	43,800	
Other Fixed Capital	4,400	
Total Fixed Capital		48,000
Working Capital		6,000
Total Capital Required		54,000

ENERGY REQUIREMENTS
(per MDMT)

	Steam (kg)	Power (kWh)
Pulping	–	220
Board Making	4,500	220
Effluent Treatment	–	30
Misc. & Auxiliaries	1,000	180
Total	5,500	650

OPERATING COST*
($/MDMT)

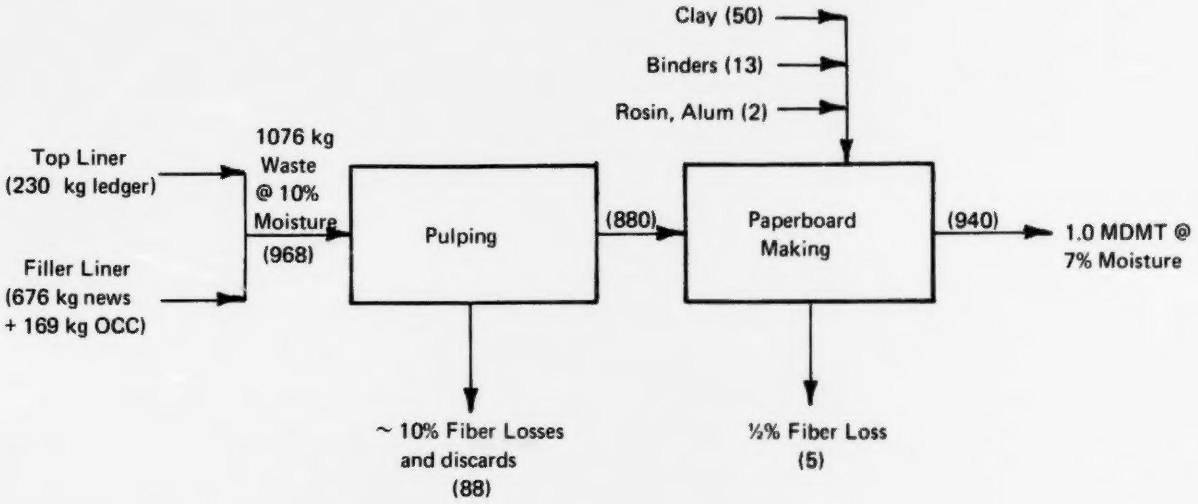
Fiber Furnish	66.5	
Other Raw Materials	11.5	
Total Raw Materials Cost		78.0
Labor + Fringe @ 32% of Hourly Rate	20.1	
Supplies	12.3	
Energy	22.4	
Factory Overhead	11.9	
Total Conversion Costs		66.7
Capital-Related Costs		31.0
● Total Factory Operating Cost		175.7 (159.4/MDST)
GS&A	11.9	
Freight Out	15.0	
Total Cost of Sales		26.9
● Total Delivered Cost		202.6 ($183.8/MDST)

*Totals may not add due to rounding.

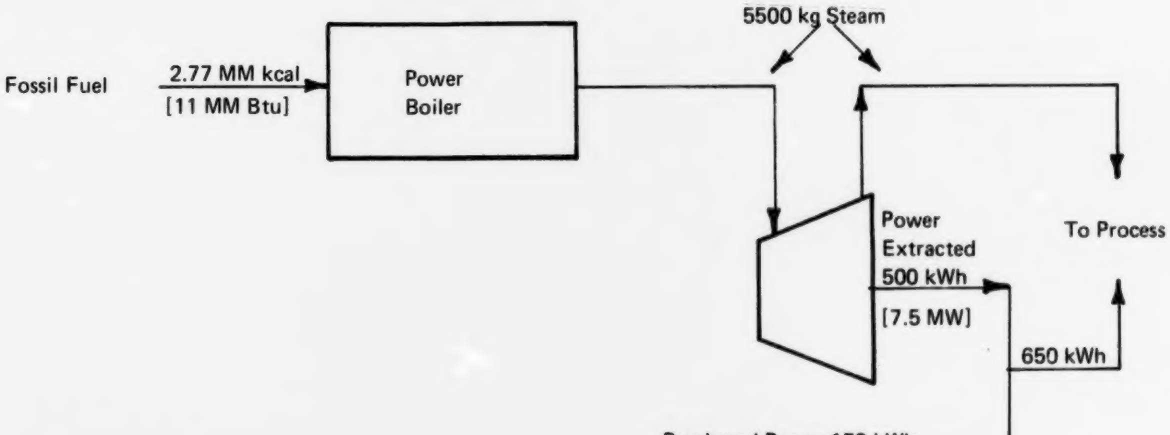
FIG. IX-H-1

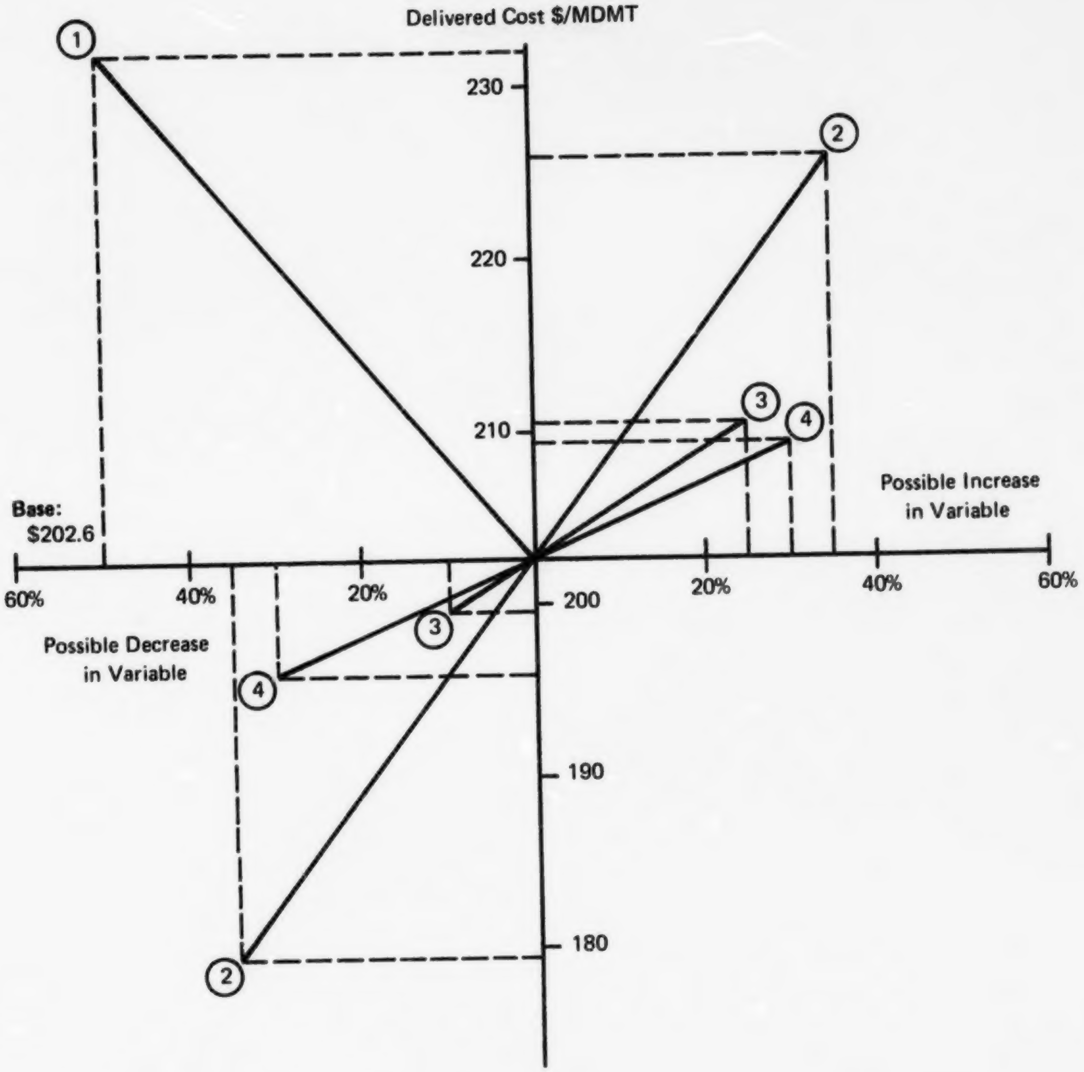
MATERIAL AND ENERGY BALANCE

(Basis: 1.0 MDMT 18-pt clay coated)


Clay (50)
Binders (13)
Rosin, Alum (2)
Top Liner
(230 kg ledger)
Filler Liner
(676 kg news
+ 169 kg OCC)
1076 kg
Waste
@ 10%
Moisture
(968)
Pulping
(880)
Paperboard
Making
(940)
1.0 MDMT @
7% Moisture
~ 10% Fiber Losses
and discards
(88)
½% Fiber Loss
(5)

( ) Indicates BD kg


Fossil Fuel
2.77 MM kcal
[11 MM Btu]
Power
Boiler
5500 kg Steam
Power
Extracted
500 kWh
[7.5 MW]
To Process
650 kWh
Purchased Power 150 kWh



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+ 0, −50	360	360	180
2. A Delivered Cost of Fiber,* $/ADMT	+20, −20	130	156	104
B	+50, −50	43	64	22
3. Fixed Capital, $ Million	+25, −10	48	60	43
4. Cost of Energy, $/MM Btu	+30, −30	1.8	2.3	1.3

*2A—Ledger, 2B—News and OCC (Composite Variation +35%, −35%)

FIGURE IX–H–2 SENSITIVITY OF THE MANUFACTURING COST OF FOLDING BOXBOARD (18 POINT CLAY COATED, SECONDARY) TO KEY VARIABLES

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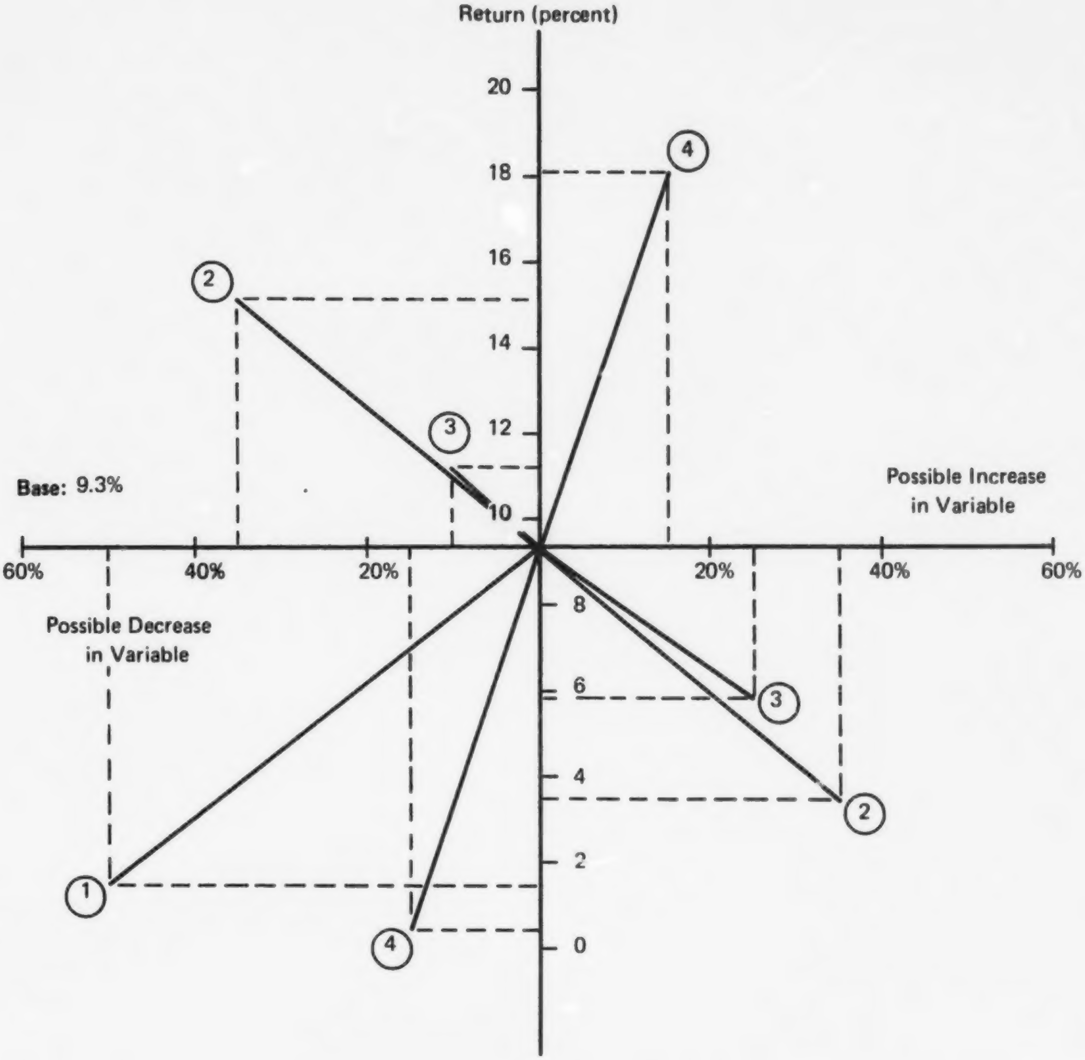


KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+ 0, −50	360	360	180
2. A Delivered Cost of Fiber,* $/ADMT	+20, −20	130	156	104
B	+50, −50	43	64	22
3. Fixed Capital, $ Million	+25, −10	48	60	43
4. Selling Price, $/MDMT	+15, −15	240	276	204

*2A—Ledger, 2B—News and OCC (Composite Variation +35%, −35%)

FIGURE IX–H–3 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF FOLDING BOXBOARD (18 POINT CLAY COATED, SECONDARY) TO KEY VARIABLES

TABLE IX-H-4

DESIGN BASIS

Functional Group	Folding Boxboard	Process	Integrated to 730 ADMT bl kraft
Grade	SBS Board (bleached foodboard)	Fiber Furnish	Kraft slush pulp (60% bl SW, 40% bl HW)
Basis Weight	293 g/m² (180 lb/3000 sq ft)	Pulp Yield	n.a.
Production	450 MDMT/day; 150,000 MDMT/yr	Mill Location	Southeast
Net Operating Days	330/yr	Boundary Limits	Transfer of slush pulp to board making

CAPITAL REQUIREMENTS* ($000)

Physical Plant	35,100	
Other Fixed Capital	3,500	
Total Fixed Capital		39,000
Working Capital		9,000
Total Capital Required		48,000

ENERGY REQUIREMENTS (per MDMT)

	Steam (kg)	Power (kWh)
Stock Preparation	–	150
Board Making	3,000	150
Effluent Treatment Misc. & Auxiliaries	400	40
Total	3,400	340

OPERATING COST* ($/MDMT)

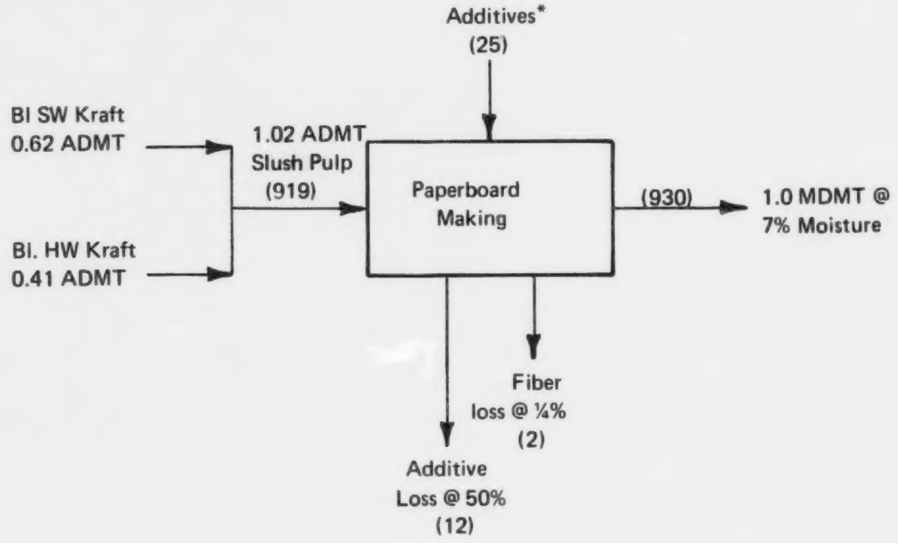
Fiber Furnish	135.7	
Other Raw Materials	13.0	
Total Raw Materials Cost		148.5
Labor & Fringe @ 32% of Hourly Rate	13.0	
Supplies	11.0	
Energy	8.5	
Factory Overhead	5.0	
Total Conversion Costs		37.6
Capital-Related Costs		19.8
● Total Factory Operating Cost		205.9 ($186.8/MDST)
GS&A	13.0	
Freight Out	30.0	
Total Cost of Sales		43.0
● Total Delivered Cost		248.8 ($225.7/MDST)

*Totals may not add due to rounding.

FIGURE IX-H-4

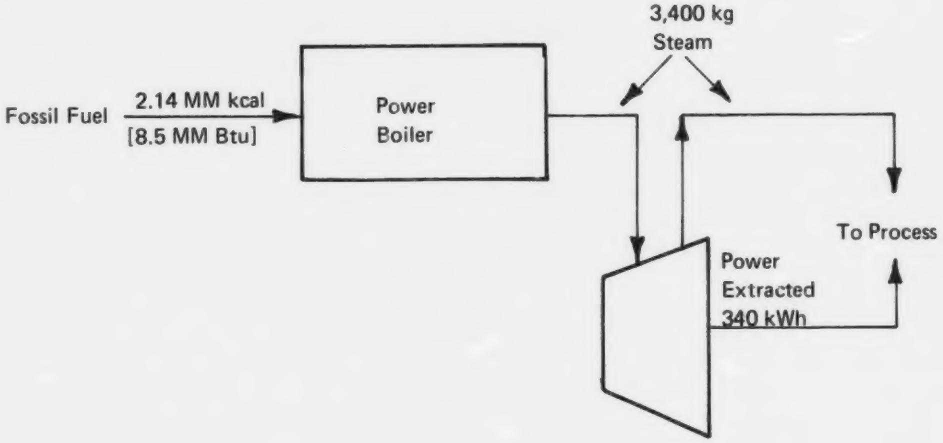
MATERIAL AND ENERGY BALANCE

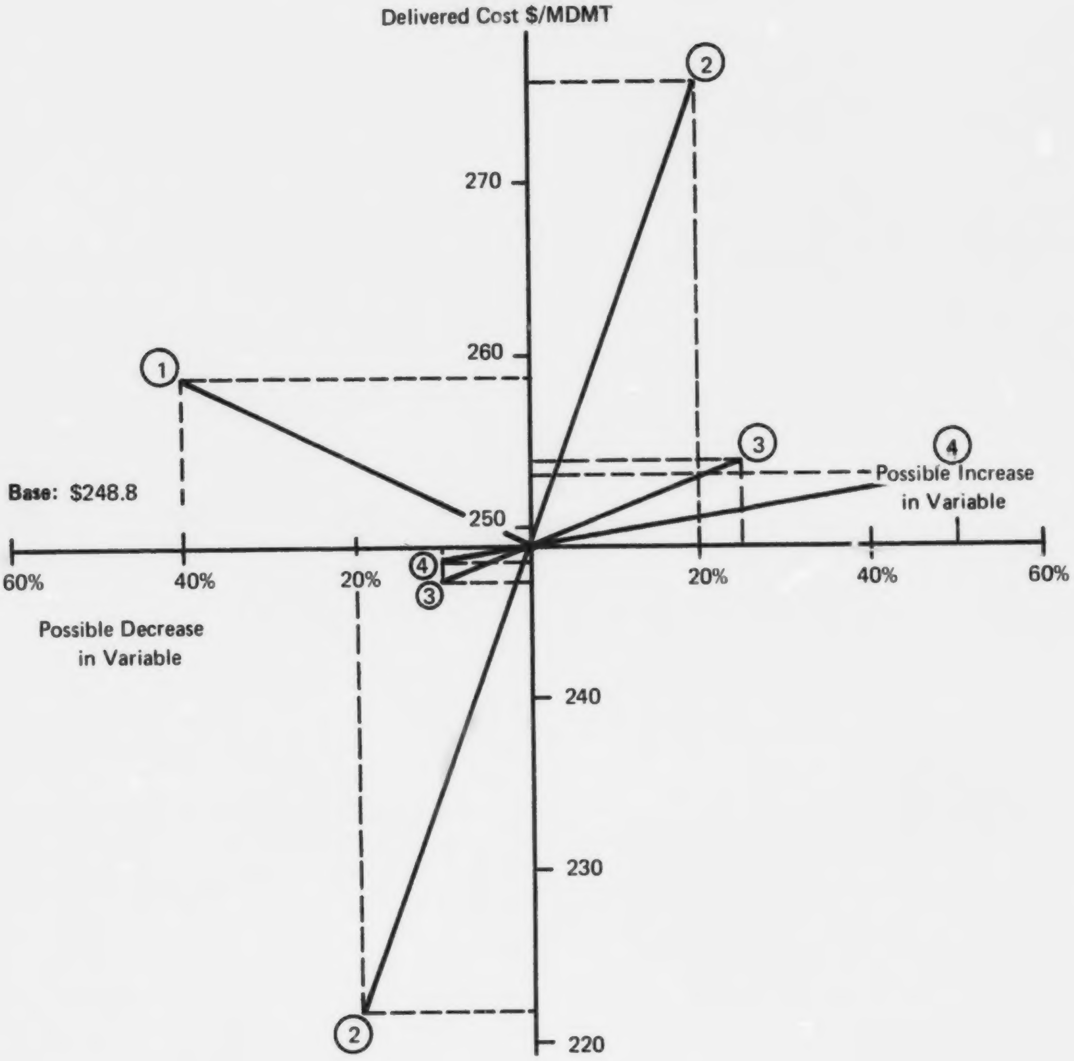
(Basis: 1.0 MDMT board, rolls)


Additives*
(25)
Bl SW Kraft
0.62 ADMT
1.02 ADMT
Slush Pulp
(919)
Paperboard
Making
(930)
1.0 MDMT @
7% Moisture
Bl. HW Kraft
0.41 ADMT
Fiber
loss @ ¼%
(2)
Additive
Loss @ 50%
(12)

( ) Indicates BD kg

*Rosin 10 kg, alum 15 kg


3,400 kg
Steam
Fossil Fuel
2.14 MM kcal
[8.5 MM Btu]
Power
Boiler
To Process
Power
Extracted
340 kWh



KEY VARIABLES		Percent Variation	Best Guess	Possible High	Possible Low
1.	Scale of Operations, MTPD	+ 0, – 40	450	450	270
2.	Delivered Cost of Fiber,* $/ADMT	+20, – 20	129	103	155
3.	Fixed Capital, $ Million	+25, – 10	39	49	35
4.	Cost of Energy, $/MMBtu	+50, – 10	1.0	1.5	0.9

*Average Slush Pulp Cost

FIGURE IX–H–5 SENSITIVITY OF THE MANUFACTURING COST OF SBS BOARD (UNCOATED BLEACHED FOODBOARD, VIRGIN) TO KEY VARIABLES

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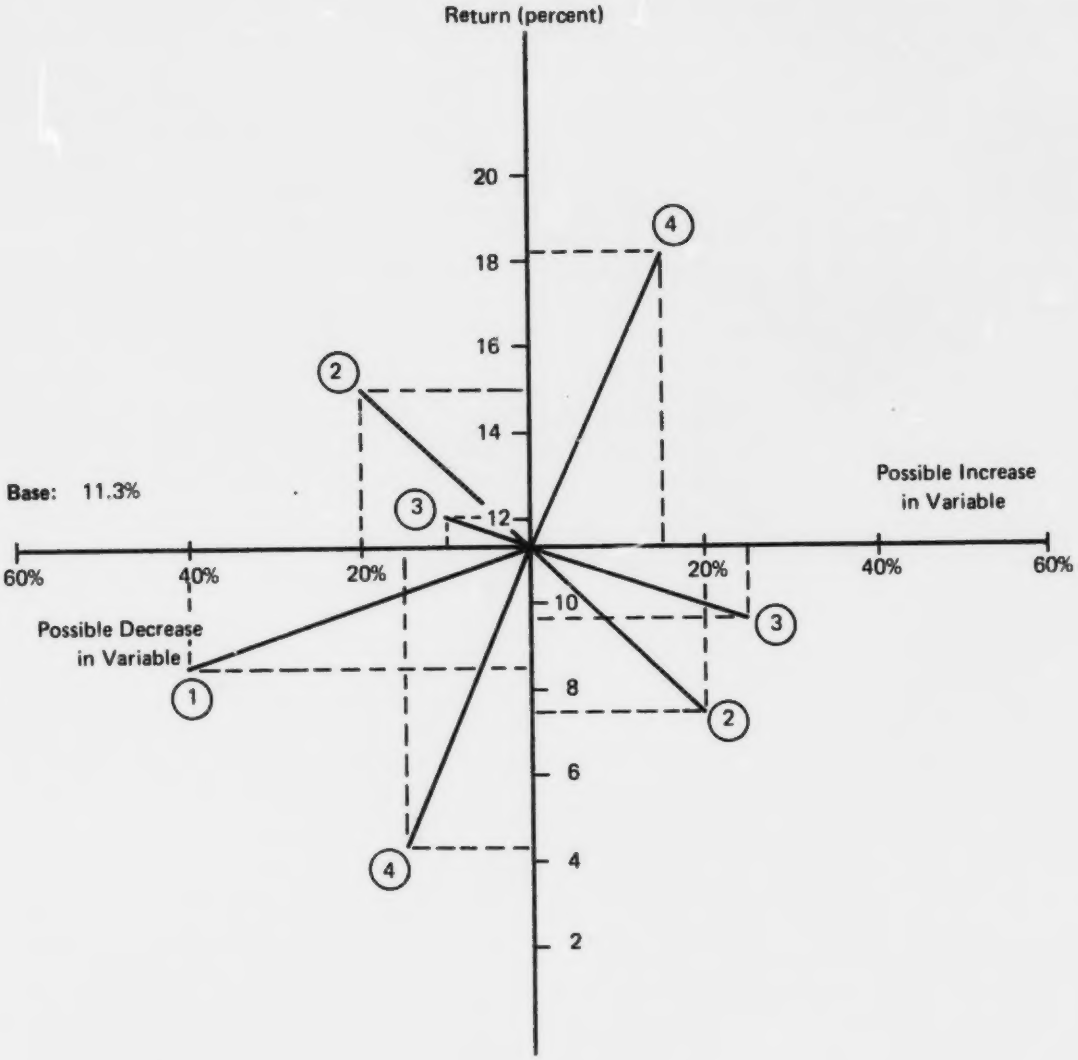

KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations,** MTPD	+ 0, −40	450	450	270
2. Delivered Cost of Fiber,* $/ADMT	+20, −20	129	155	103
3. Fixed Capital,** $ Million	+25, −10	39	49	35
4. Selling Price, $/MDMT	+15, −15	330	380	280

*Average Slush Pulp Cost

**Variation applies to papermaking operation only; allocated fixed capital for pulp manufacture is assumed constant at $69 million.

FIGURE IX–H–6 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF SBS BOARD (UNCOATED BLEACHED FOODBOARD, VIRGIN) TO KEY VARIABLES

I. PRINTING AND WRITING PAPERS

1. Bond Paper

a. Basis of Models

Three economic models have been prepared for the production of bond paper: from virgin fiber, secondary fiber, and a blend of both. This product is made in a range of grades to suit a variety of markets. The virgin and secondary products tend to be complementary rather than competitive; thus, we have selected a furnish for each model which does not necessarily give equal quality, and we have reflected quality differences in our selling price estimates.

For the virgin fiber model, we have used a furnish containing equal amounts of bleached hardwood and softwood kraft pulps. For the secondary fiber model, we have used a pulp substitute deinking mixture of 40% IBM cards, 40% white ledger, and 20% No. 1 news. The blended model uses the pulp substitute deinking mixture for 33% of the furnish and the bleached kraft pulp mixture for the remaining 67%. (In practice, the proportion of secondary fiber would be varied to meet the quality requirements of a range of grades run to meet specific orders and customer requirements.)

We have estimated a selling price for the secondary fiber product of $450/MDMT, discounted 10% from the virgin fiber selling price of $500/MDMT. We have estimated that the inclusion of No. 1 news in the blended product would not cause a noticeable deterioration of quality and that the blended product would be sold as an essentially virgin fiber product at no discount. The effect on return on capital of variations in these selling prices can be determined from the sensitivity charts for each model.

Virgin and secondary bond paper products are made in all regions of the country; the secondary fiber mills are located in metropolitan areas, with some concentration in the Northeast and North Central regions. We have chosen a Northeast location for all models as representative of existing industry patterns and offering a common basis for comparison. Regional variations can be evaluated through use of the regional data previously presented (Table IX-C-1), in combination with the relevant sensitivity charts.

The virgin and blended models are sized at 272 MDMT/day to reflect a competitive scale of operations for a new bond paper machine installation. This machine would be integrated to a larger (730 ADMT/day) new pulping facility, with the excess pulp used elsewhere on site. (See Slush Pulp Cost, Section A.6.)

Since the blended model represents the bond paper portion of a larger total new mill installation, it is not directly indicative of the economics or the possible advantages of adding secondary fiber capacity in a situation where existing machine capacity might be expanded.

(See Containerboard, Section E.1.a.) We have not attempted to determine how many machines have the potential for capacity expansion, nor have we idled pulp mill capacity to compensate for replacement with secondary fiber in the blended model. The blended model provides a framework from which the potential costs and profitability of adding incremental capacity may be determined, given the specific conditions.

For secondary bond paper, we have selected capacity at 136 MDMT/day. This is quite large relative to the existing industry, and it is unlikely that a new mill of this size could find sufficient fiber supply at competitive cost. However, this capacity represents a compromise between existing conditions of capacity and fiber availability, and a scale of operations large enough to be competitive with a virgin fiber machine. New sources of fiber would presumably have to be developed to supply a mill of this size.

b. Comparative Economics

Table IX-I-1 summarizes the total capital, delivered cost, and return on capital for the three bond paper models. Total fixed capital for the virgin and blended models of $74 million and $69 million respectively includes papermaking, deinking for the blended model, and an allocation of the capital costs for bleached kraft slush pulp production. On-site power generation is included for both, by virtue of their integration to the larger pulping facility.

Total fixed capital for the secondary fiber model of $30 million is based on a single machine and includes pulp substitute deinking. It does not include on-site power generation, as the total steam requirements are below the minimum we have established for on-site power. (See Section C.2.d.) The total capital requirements and investment per daily ton for secondary bond paper are lower than for either the virgin or blended models. The implications of these differences will be discussed in the profitability analysis which follows.

The delivered cost for secondary bond paper at $422.2/MDMT is higher than either the virgin product at $315.4 or the blended product at $343.1. It has the highest raw material cost of the three models, because of the high cost of pulp substitute deinking grades relative to virgin fiber pulp. (The effect of fiber raw material cost on total delivered cost is indicated in Figure IX-I-5.) In addition, the high conversion and capital-related costs associated with a small scale of operations, and the higher costs of a nonintegrated operation highlighted by a relative sensitivity to energy cost, increase the delivered cost of the secondary fiber model relative to the other two. The high cost of pulp substitute deinking grades of secondary fiber relative to virgin fiber hold the operating costs for both the blended and secondary models above the virgin fiber model even at the low end of the secondary fiber cost range.

The 22.5% pre-tax return on fixed capital for the virgin fiber model is the most attractive. However, by virtue of its lower fixed capital, the blended model is almost as attractive at 20.5%, despite its higher delivered cost. As indicated on the sensitivity chart for return on capital (Figure IX-I-9), if secondary fiber were at the low end of its cost range, the ROI for the blended model would be about equal to that of the virgin fiber model.

For the secondary fiber model, low cost fiber, increased scale of operations, and elimination of the selling price differential would all be required before it could have a return on capital as attractive as that of the virgin or blended fiber model, even though its capital requirement is the smallest of the three. The key to making the S/F model more attractive and increasing the ROI for the blended model is the availability of sufficient quantity of secondary fiber at a relatively low and stable cost.

We have included an operating cost estimate only for one additional model, a nonintegrated virgin fiber mill using market pulp as the fiber raw material. Table IX-I-8 compares this model with the 100% secondary fiber model. The costs have been developed by using the same capacity as the secondary fiber model and substituting market pulp for secondary fiber, with corresponding reductions in conversion and capital costs.

Thus, the nonintegrated virgin fiber model represents a new single-machine installation. Since this is a hypothetical case not directly representative of either the existing industry or probable capacity expansions, we consider it unrealistic to calculate its sensitivity and profitability. Our intent is to provide a comparison on an equivalent basis of high-grade pulp substitute deinking waste papers and market pulp as alternative fiber sources for nonintegrated papermaking.

The nonintegrated virgin fiber model provides a framework for estimating actual mill costs, but one must keep in mind that the nonintegrated paper industry has no new or recent installations, and that its production is not accurately characterized by a single-machine operation.

The total delivered cost of $504.5/MDMT and the raw material cost of $319.1/MDMT for the nonintegrated virgin fiber model compare with a delivered cost of $422.2 and raw material cost of $212.4 for secondary fiber. These differences are due to fiber source alone, and would also exist at other levels of actual operating cost if the costs of conversion, capital, and sales differed from those of our models. The fiber cost differences readily explain the high cost and extensive use of high-grade pulp substitute deinking secondary fiber sources.

Accordingly, the existing nonintegrated paper mills could provide a ready market, even at reduced product selling prices, if new sources of these secondary fiber grades could be developed. Utilization would remain high at much greater secondary fiber tonnages than presently generated, so long as market pulp prices were at a level where our comparison is valid.

TABLE IX-I-1

Economic Comparison of Bond Paper (Rolls) Manufacture

Functional Group	Printing and Writing Papers		
Grade	Bond		
Basis Weight (g/m^2)	70 (47 lbs/3300 sq ft)		
Fiber Furnish	100% Virgin	100% Secondary	67% Virgin 33% Secondary
Plant Size (MT/DAY)	272	136	272
Plant Location	Northeast	Northeast	Northeast
Plant Specifics	Integrated	Non-Integrated	Integrated
Total Fixed Capital* ($ Million)	74	30	69
($000/Daily Ton)	272	220	253
Total Delivered Cost ($/MDMT)	315.4	422.2	343.1
Raw Materials ($/MT, delivered)	170.6	212.4	184.1
Conversion ($/MT)	49.2	102.7	59.2
Capital-Related ($/MT)	31.6	51.1	35.8
Sales Cost (less freight) ($/MT)	34.0	34.0	34.0
Freight in ($/MT Product)**	18.0	20.0	18.8
Freight out ($/MT Product)	30.0	22.0	30.0
Selling Price ($/MDMT)	500	450	500
Return on Fixed Capital,*pre-tax (%)	22.5	4.2	20.5

* Including pulping

** Not included in total delivered cost

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TABLE IX-I-2

DESIGN BASIS

Functional Group	Printing & Writing Papers	Process	Integrated to bl. kraft
Grade	Bond paper	Fiber Furnish	100% virgin bl. kraft slush pulp (50% SW, 50% HW)
Basis Weight	70 g/m^2 (47 lb/3300 sq ft)	Pulp Yield	n.a.
Production	272 MDMT/day; 90,000 MDMT/yr (rolls)	Mill Location	Northeast
Net Operating Days	330/yr	Boundary Limits	Transfer of slush pulp through paper making

CAPITAL REQUIREMENTS* ($000)

Physical Plant	33,700	
Other Fixed Capital	3,000	
Total Fixed Capital		37,000
Working Capital		7,000
Total Capital Required		44,000

ENERGY REQUIREMENTS (per MDMT)

	Steam (kg)	Power (kWh)
Stock Preparation	–	160
Paper Making	2,700	160
Effluent Treatment	–	20
Misc. & Auxiliaries	500	20
Total	3,200	360

OPERATING COST* ($/MDMT)

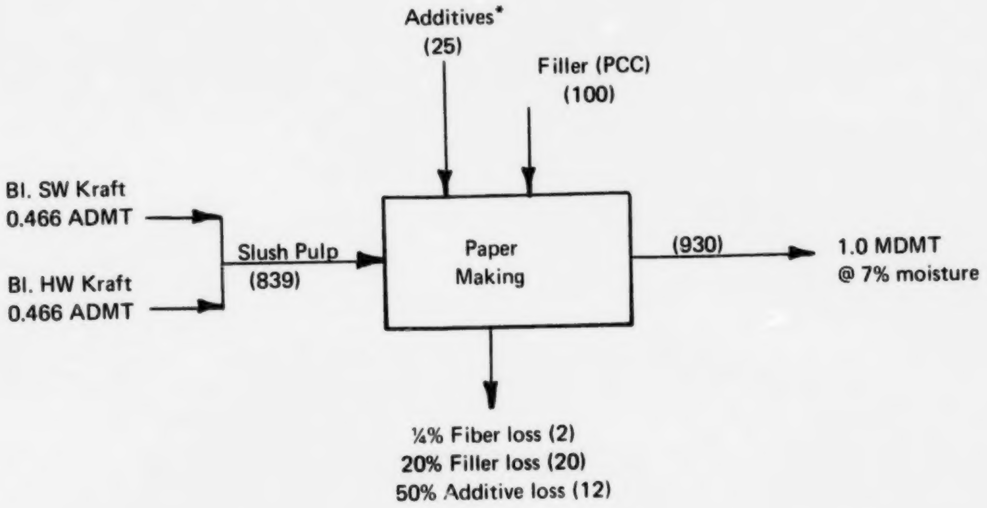
Fiber Furnish	146.6	
Other Raw Materials	24.0	
Total Raw Materials Cost		170.6
Labor + Fringe @ 32% of Hourly Rate	13.7	
Supplies	15.0	
Energy	14.8	
Factory Overhead	5.7	
Total Conversion Costs		49.2
Capital-Related Costs		31.6
• Total Factory Operating Cost		251.4 ($228.1/MDST)
GS&A	34.0	
Freight Out	30.0	
Total Cost of Sales		64.0
• Total Delivered Cost		315.4 ($286.1/MDST)

*Totals may not add due to rounding.

FIGURE IX-I-1

MATERIAL AND ENERGY BALANCE

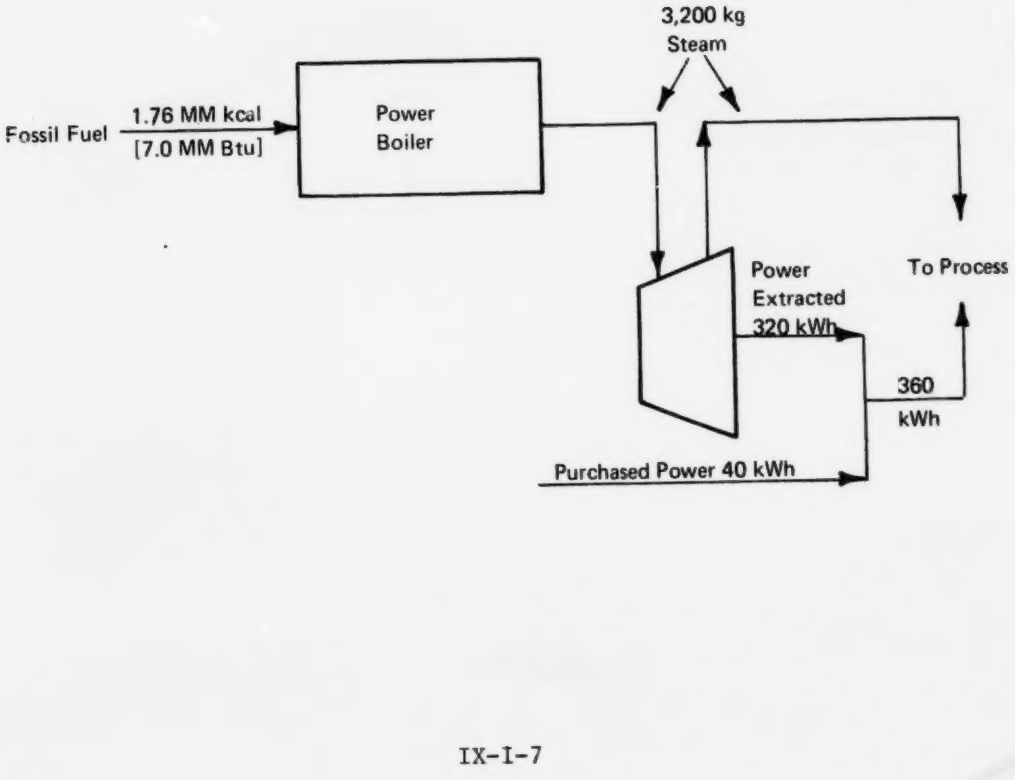
(Basis: 1.0 MDMT bond paper, rolls)



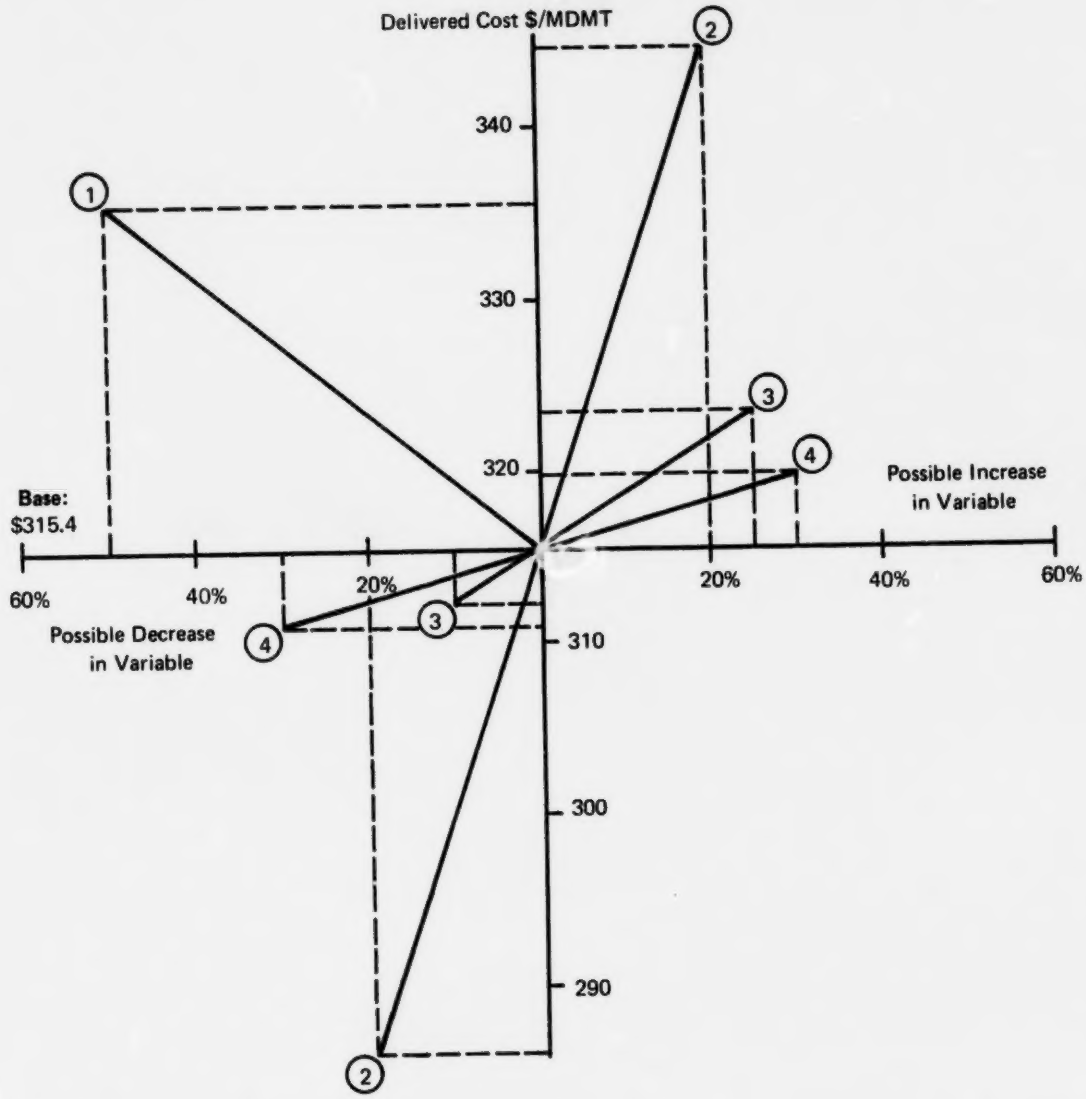
Additives*
(25)
Filler (PCC)
(100)
Bl. SW Kraft
0.466 ADMT
Bl. HW Kraft
0.466 ADMT
Slush Pulp
(839)
Paper
Making
(930)
1.0 MDMT
@ 7% moisture
¼% Fiber loss (2)
20% Filler loss (20)
50% Additive loss (12)

( ) Indicates BD kg

*Rosin 10 kg, alum 15 kg



3,200 kg
Steam
Fossil Fuel
1.76 MM kcal
[7.0 MM Btu]
Power
Boiler
Power
Extracted
320 kWh
To Process
360
kWh
Purchased Power 40 kWh



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+ 0, – 50	272	272	136
2. Delivered Cost of Fiber,* $/ADMT	+20, – 20	155	186	124
3. Fixed Capital, $ Million	+25, – 10	37	46	33
4. Cost of Energy, $/MMBtu	+30, – 30	2.0	2.6	1.4

*Average Slush Pulp Cost

FIGURE IX–I–2 SENSITIVITY OF THE MANUFACTURING COST OF BOND PAPER (VIRGIN) TO KEY VARIABLES

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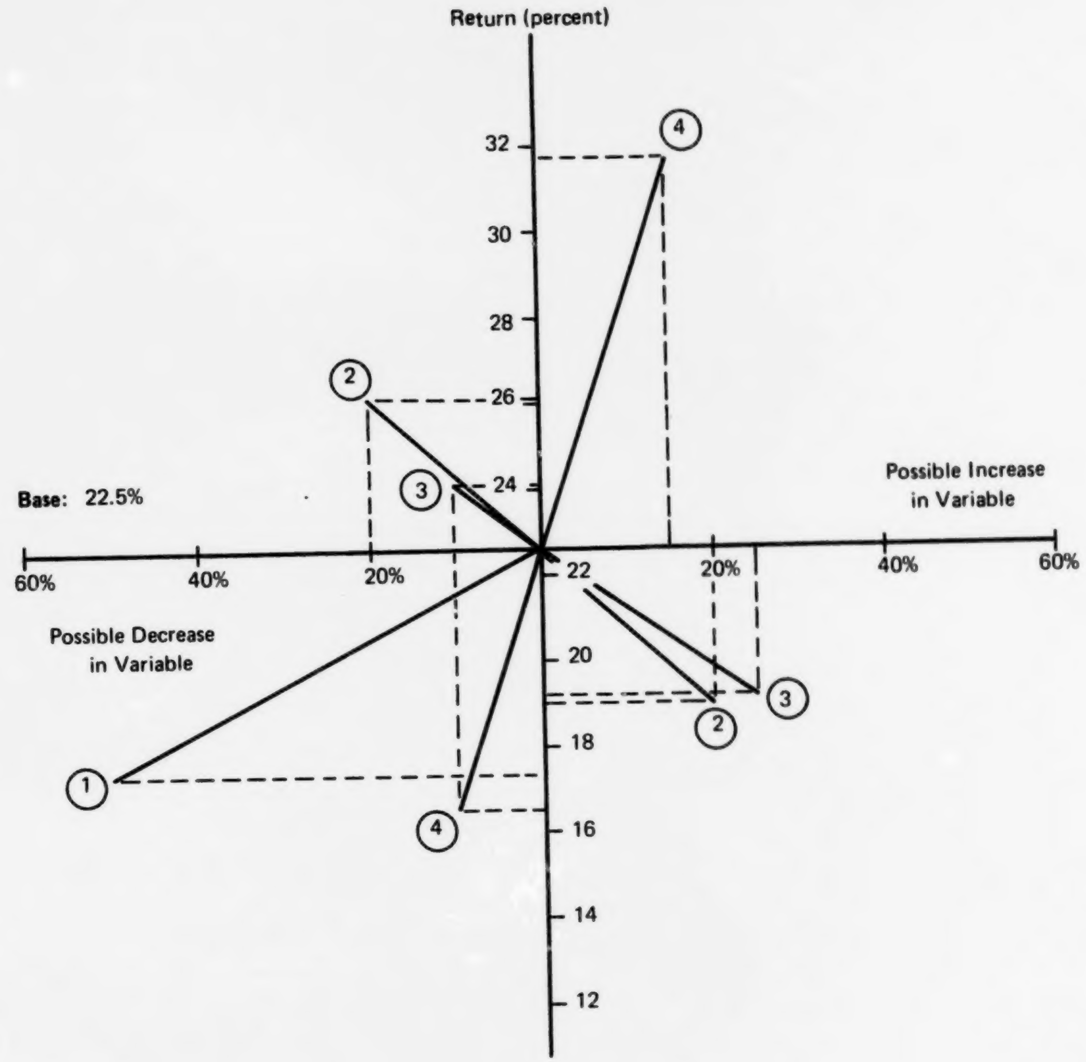

KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations,** MTPD	+ 0, −50	272	272	136
2. Delivered Cost of Fiber,* $/ADMT	+20, −20	155	186	124
3. Fixed Capital,** $ Million	+25, −10	37	46	33
4. Selling Price, $/MDMT	+15, −10	500	575	450

*Average Slush Pulp Cost

**Variation applies to papermaking operation only; allocated fixed capital for pulp manufacture is assumed constant at $37 million.

FIGURE IX–I–3 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF BOND PAPER (VIRGIN) TO KEY VARIABLES

TABLE IX-I-4

DESIGN BASIS

Functional Group	Printing & Writing Papers	Process	S/F pulping and de-inking
Grade	Bond paper	Fiber Furnish	100% S/F
Basis Weight	70 g/m^2 (47 lb/3300 sq ft)	Pulp Yield	82% of AD secondary fiber to MD paper
Production	136 MDMT/day; 45,000 MDMT/yr (rolls)	Mill Location	Northeast
		Boundary Limits	S/F preparation through paper making
Net Operating Days	330/yr		

CAPITAL REQUIREMENTS*
($000)

Physical Plant	27,300	
Other Fixed Capital	2,700	
Total Fixed Capital		30,000
Working Capital		5,000
Total Capital Required		35,000

ENERGY REQUIREMENTS
(per MDMT)

	Steam (kg)	Power (kWh)
De-inking	500	300
Stock Preparation	–	160
Paper Making	2,700	160
Effluent Treatment	–	20
Misc. & Auxiliaries	600	60
Total	3,800	700

OPERATING COST*
($/MDMT)

Fiber Furnish	192.3	
Other Raw Materials	20.3	
Total Raw Materials Cost		212.4
Labor + Fringe @ 32% of Hourly Rate	31.8	
Supplies	19.7	
Energy	31.5	
Factory Overhead	19.6	
Total Conversion Costs		102.7
Capital-Related Costs		51.1
● Total Factory Operating Cost		366.2 ($332.2/MDST)
GS&A	34.0	
Freight Out	22.0	
Total Cost of Sales		56.0
● Total Delivered Cost		422.2 ($383.0/MDST)

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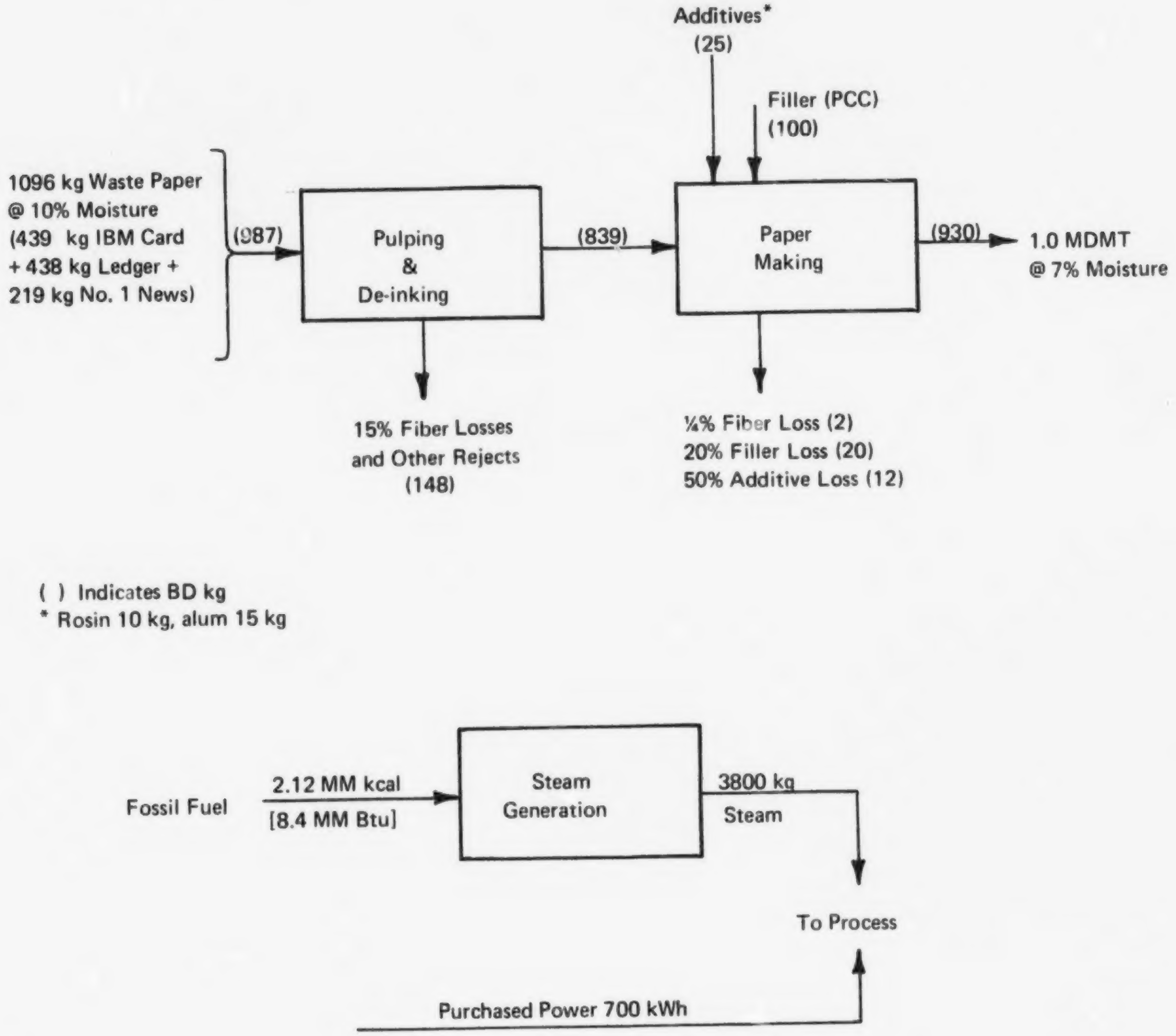
*Totals may not add due to rounding.

FIGURE IX-I-4

MATERIAL AND ENERGY BALANCE

(Basis: 1.0 MDMT bond paper, rolls)


Additives*
(25)
Filler (PCC)
(100)
1096 kg Waste Paper
@ 10% Moisture
(439 kg IBM Card
+ 438 kg Ledger +
219 kg No. 1 News)
(987)
Pulping
&
De-inking
(839)
Paper
Making
(930)
1.0 MDMT
@ 7% Moisture
15% Fiber Losses
and Other Rejects
(148)
¼% Fiber Loss (2)
20% Filler Loss (20)
50% Additive Loss (12)
Fossil Fuel
2.12 MM kcal
[8.4 MM Btu]
Steam
Generation
3800 kg
Steam
To Process
Purchased Power 700 kWh

( ) Indicates BD kg

* Rosin 10 kg, alum 15 kg

TABLE IX-I-5

ESTIMATED OPERATING COST FOR THE MANUFACTURE OF BOND PAPER FROM 100% SECONDARY FIBER

Item	Unit	Unit Cost ($)	Units per MDMT	Operating Cost	
				$/MDMT	$000/Yr
RAW MATERIALS					
Secondary Fiber:					
IBM Card (40%)	M.Ton	230.0	0.445	102.4	4,610
Ledger (40%)	M.Ton	157.0	0.445	69.9	3,140
No. 1 News (20%)	M.Ton	45.0	0.223	10.0	450
Filler, PCC	M.Ton	100	0.1	10.0	450
Chemicals					
De-inking				5.8	260
Papermaking				12.0	540
Other				2.5	110
TOTAL RAW MATERIALS COST				212.4	9,560
CONVERSION (less capital-related):					
Labor + fringe @ 32% hourly rate					
Direct	man-hr	6.3	2.2	13.8	620
Indirect	man-hr	6.3	1.7	10.7	480
Maintenance	man-hr	7.3	1.0	7.3	330
Supplies					
Operating				5.7	260
Packaging				4.0	180
Maintenance				10.0	450
Fuel					
Steam/Power Generation					
Residue Fuel	MM Btu				
Fossil Fuel	MM Btu	2.0	8.4	16.8	760
Lime Reburning					
Fossil Fuel	MM Btu				
Power					
Extracted	kWh				
Purchased	kWh	0.021	700	14.7	660
Factory Overhead				19.6	880
TOTAL CONVERSION COST (less capital-related)				102.7	4,620
CAPITAL-RELATED					
Depreciation @ 5.4% Fixed Capital				36.0	1,620
Local taxes & ins. @ 2.5% PPC				15.1	680
TOTAL CAPITAL-RELATED				51.1	2,300
TOTAL FACTORY OPERATING COST				366.2	16,480
COST OF SALES					
General Administration				14.0	630
Sales Expense				20.0	900
Freight Out				22.0	990
TOTAL COST OF SALES				56.0	2,520
TOTAL DELIVERED COST (excl. interest on borrowed funds for fixed and working capital)				422.2	19,000

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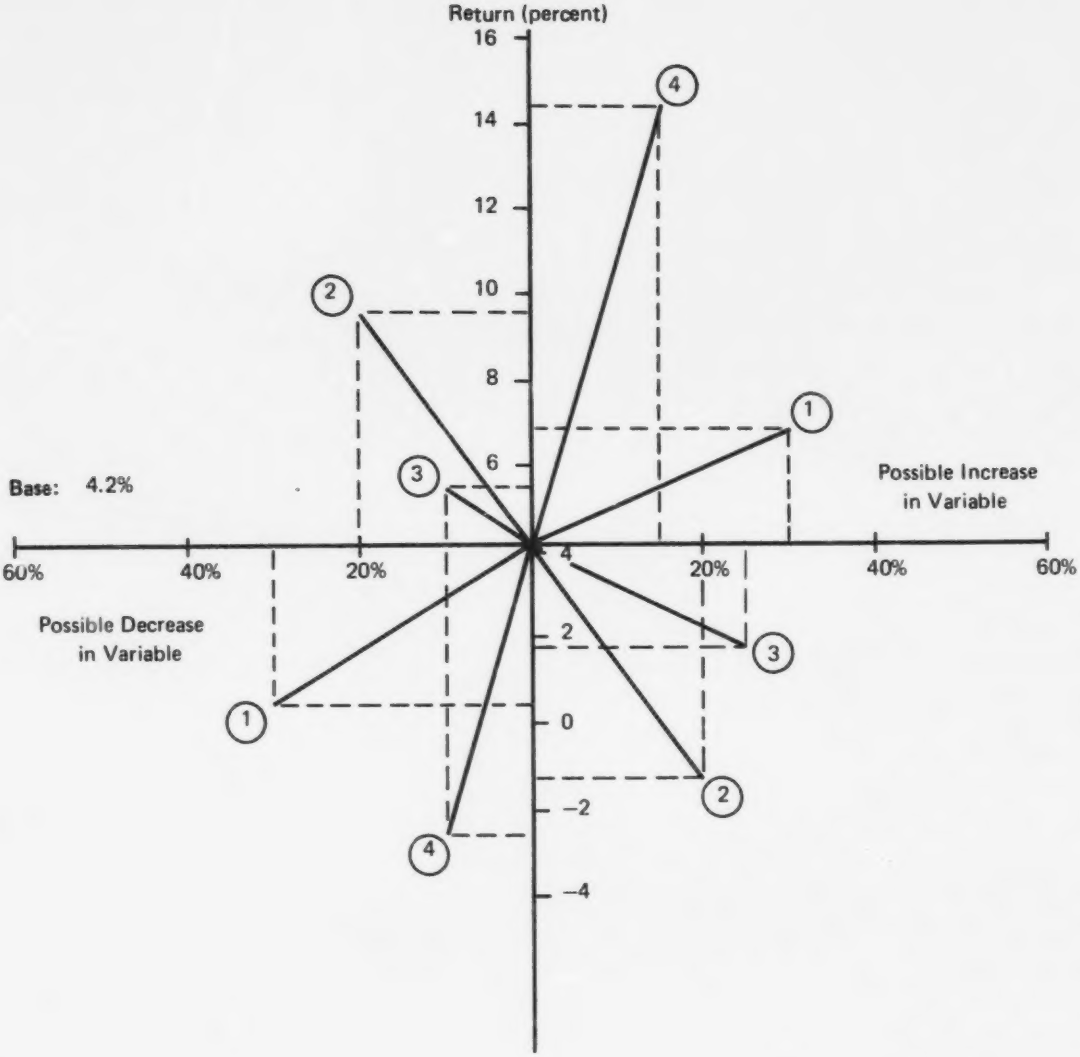

KEY VARIABLES		Percent Variation	Best Guess	Possible High	Possible Low
1.	Scale of Operations, MTPD	+30, −30	136	177	95
2.	Delivered Cost of Fiber,* $/ADMT	+20, −20	164	197	131
3.	Fixed Capital, $ Million	+25, −10	30	38	27
4.	Selling Price, $/MDMT	+15, −10	450	518	405

*Composite Average Secondary Fiber Cost

FIGURE IX–I–6 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF BOND PAPER (SECONDARY) TO KEY VARIABLES

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TABLE IX-I-6

DESIGN BASIS

Functional Group	Printing & Writing Papers	Process	Pulp substitute de-inking, integrated to bleached kraft
Grade	Bond paper	Fiber Furnish	67% virgin bl. kraft slush pulp, 33% S/F
Basis Weight	70 g/m^2 (47 lb/3300 sq ft)	Pulp Yield	82% AD S/F to MD paper
Production	272 MDMT/day; 90,000 MDMT/yr (rolls)	Mill Location	Northeast
		Boundary Limits	Transfer of slush pulp and S/F preparation through paper making
Net Operating Days	330/yr		

CAPITAL REQUIREMENTS* ($000)

Physical Plant	37,800	
Other Fixed Capital	3,800	
Total Fixed Capital		42,000
Working Capital		8,000
Total Capital Required		50,000

ENERGY REQUIREMENTS (per MDMT)

	Steam (kg)	Power (kWh)
De-inking	175	100
Stock Preparation	–	160
Paper Making	2,700	160
Effluent Treatment	–	20
Misc. & Auxiliaries	525	60
Total	3,400	500

OPERATING COST* ($/MDMT)

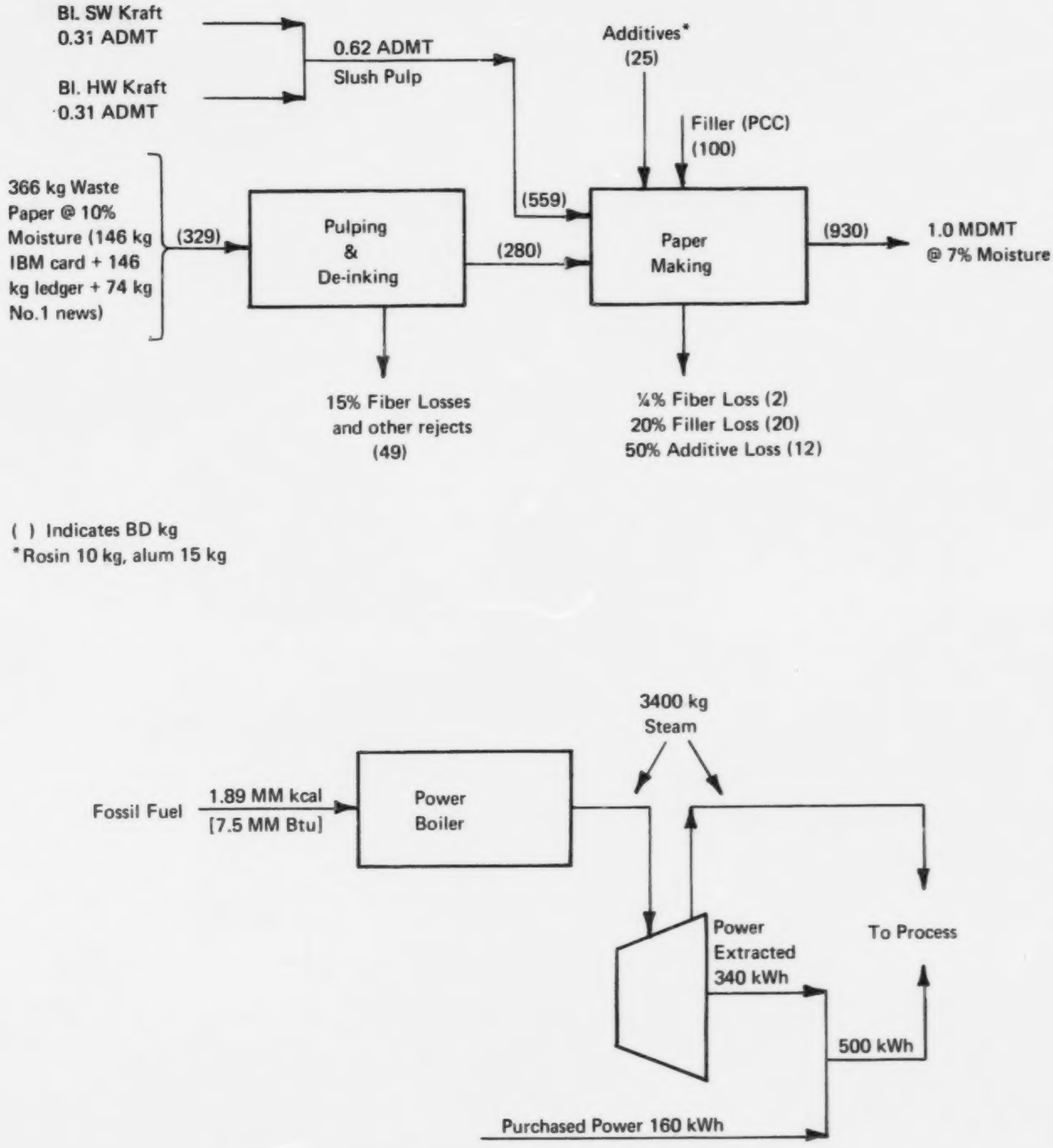
Fiber Furnish	158.3	
Other Raw Materials	25.9	
Total Raw Materials Cost		184.1
Labor + Fringe @ 32% of Hourly Rate	17.0	
Supplies	16.3	
Energy	18.4	
Factory Overhead	7.2	
Total Conversion Costs		59.2
Capital-Related Costs		35.8
• Total Factory Operating Cost		279.1 ($253.2/MDST)
GS&A	34.0	
Freight Out	30.0	
Total Cost of Sales		64.0
• Total Delivered Cost		343.1 ($311.3/MDST)

*Totals may not add due to rounding.

FIGURE IX-I-7

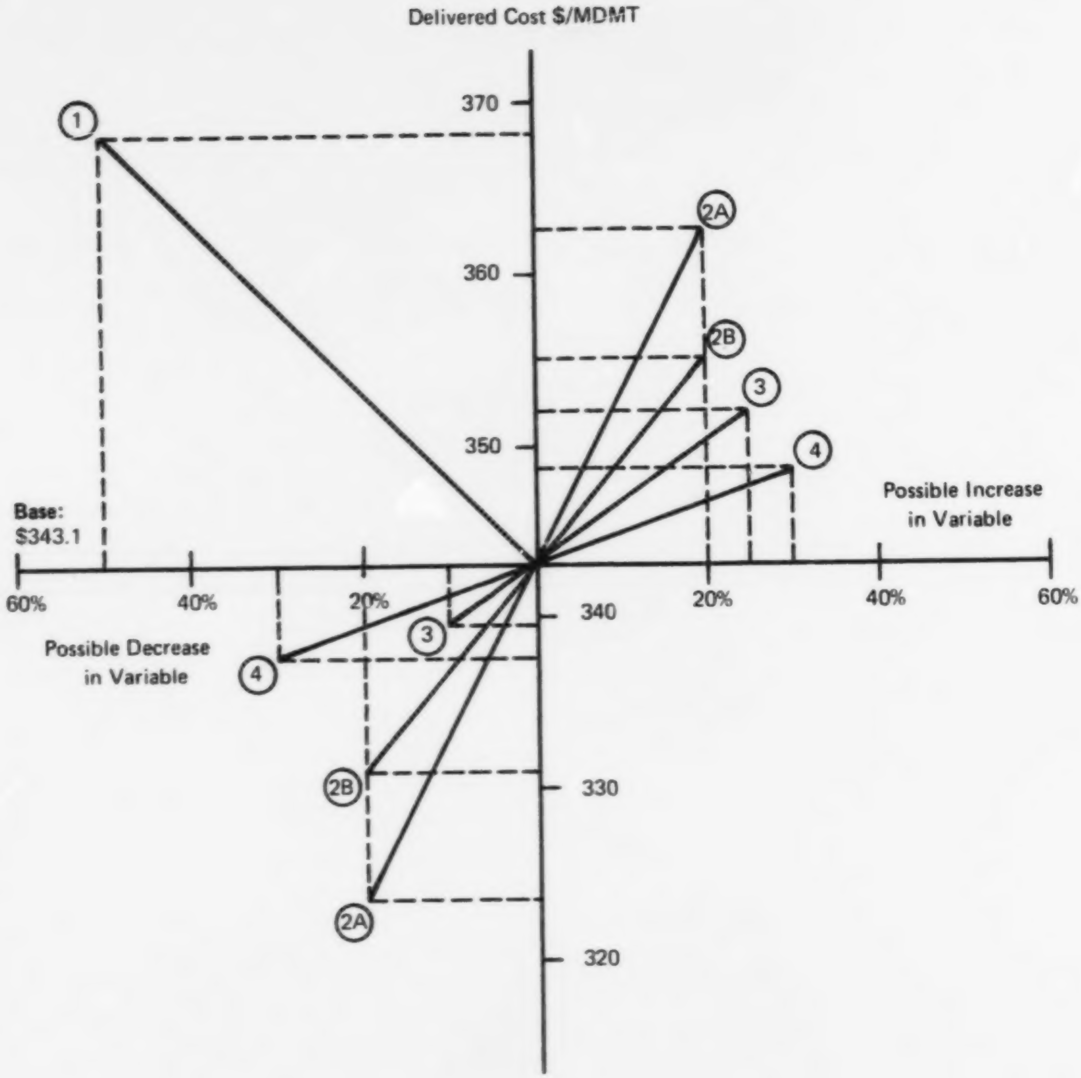
MATERIAL AND ENERGY BALANCE

(Basis: 1.0 MDMT book paper, rolls)


Bl. SW Kraft
0.31 ADMT
Bl. HW Kraft
0.31 ADMT
0.62 ADMT
Slush Pulp
Additives*
(25)
Filler (PCC)
(100)
366 kg Waste Paper @ 10% Moisture (146 kg IBM card + 146 kg ledger + 74 kg No.1 news)
(329)
Pulping & De-inking
(559)
(280)
Paper Making
(930)
1.0 MDMT
@ 7% Moisture
15% Fiber Losses and other rejects (49)
¼% Fiber Loss (2)
20% Filler Loss (20)
50% Additive Loss (12)
3400 kg
Steam
Fossil Fuel
1.89 MM kcal
[7.5 MM Btu]
Power
Boiler
Power
Extracted
340 kWh
To Process
500 kWh
Purchased Power 160 kWh

( ) Indicates BD kg

*Rosin 10 kg, alum 15 kg



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+ 0, −50	272	272	136
2. A Delivered Cost of Fiber,* $/ADMT	+20, −20	155	186	124
B		164	196	131
3. Fixed Capital, $ Million	+25, −10	42	53	38
4. Cost of Energy, $/MMBtu	+30, −30	2.0	2.6	1.4

*2A—Virgin (Average Slush Pulp Cost), 2B—Secondary Fiber (Average)

FIGURE IX–I–8 SENSITIVITY OF THE MANUFACTURING COST OF BOND PAPER (BLENDED) TO KEY VARIABLES

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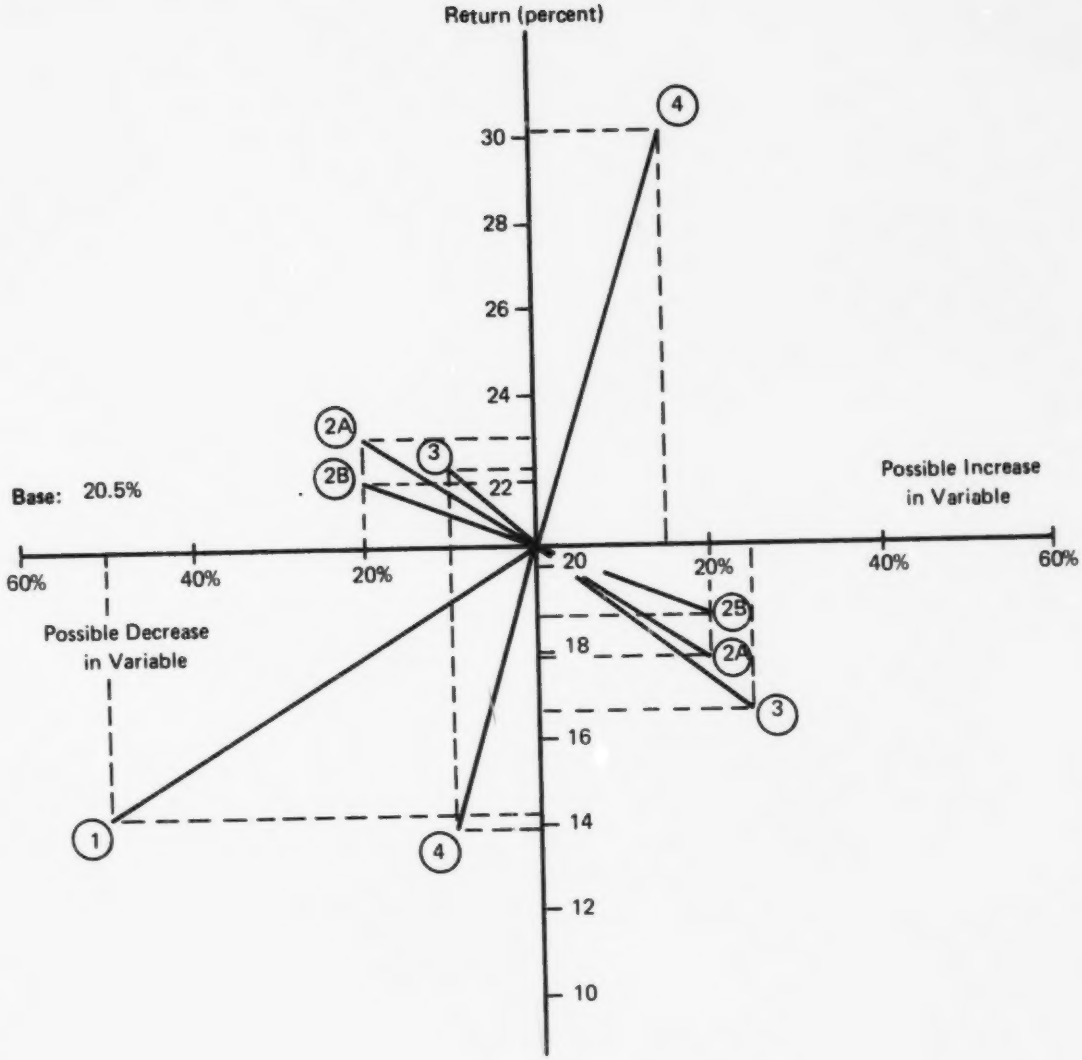

KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations,** MTPD	+ 0, −50	272	272	136
2. A B Delivered Cost of Fiber,* $/ADMT	+20, −20	155 164	186 197	124 131
3. Fixed Capital,** $ Million	+25, −10	42	53	38
4. Selling Price, $/MDMT	+15, −10	500	575	450

*1A–Virgin (Average Slush Pulp Cost), 2B–Secondary Fiber (Average)

**Variation applies to papermaking operation only; allocated fixed capital for pulp manufacture is assumed constant at $27 million.

FIGURE IX–I–9 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF BOND PAPER (BLENDED) TO KEY VARIABLES

TABLE IX-I-8

ECONOMIC COMPARISON OF BOND PAPER (ROLLS) MANUFACTURED FROM VIRGIN VS. SECONDARY FIBER (NONINTEGRATED MILL)

Functional Group	Printing & Writing Paper	
Grade	Bond	
Basis Weight (g/m^2)	70 (47 lb/3300 sq ft)	
Fiber Furnish	100% Virgin	100% Secondary
Plant Size (MT/day)	136	136
Plant Location	Northeast	Northeast
Plant Specifics	Nonintegrated	Nonintegrated
Total Fixed Capital ($/Million)	24	30
Total Delivered Cost ($/MDMT)	504.5	422.2
Raw Materials ($/MT delivered)	319.1	212.4
Conversion ($/MT)	88.3	102.7
Capital-Related ($/MT)	41.1	51.1
Sales Cost (less freight)($/MT)	34.0	34.0
Freight in ($/MT)*	20.6	20.0
Freight out ($/MT)	22.0	22.0
Selling Price ($/MT)	500	450
Return on Fixed Capital, pre-tax (%)	-8.4	4.2

*Not included in total delivered cost

TABLE IX-I-9

DESIGN BASIS

Functional Group	Printing & Writing	Process	Market Pulp
Grade	Bond paper	Fiber Furnish	100% Virgin (market pulp)
Basis Weight	70 g/m^2 (47 lb/3300 sq ft)	Pulp Yield	n.a.
Production	136 MDMT/day; 45,000 MDMT/yr (rolls)	Mill Location	Northeast
Net Operating Days	330/yr	Boundary Limits	Nonintegrated; purchased market pulp through papermaking

CAPITAL REQUIREMENTS* ($000)

Physical Plant	22,200	
Other Fixed Capital	2,200	
Total Fixed Capital		24,000
Working Capital		5,000
Total Capital Required		29,000

ENERGY REQUIREMENTS (per MDMT)

Steam (kg)	Power (kWh)
3,300	550

OPERATING COST ($/MDMT)

Fiber Furnish	305.1	
Other Raw Materials	14.0	
Total Raw Materials Cost		319.1
Labor + Fringe @ 32% of Hourly Rate	27.2	
Supplies	17.8	
Energy	26.2	
Factory Overhead	17.1	
Total Conversion Costs		88.3
Capital-Related Costs		41.1
● Total Factory Operating Cost		448.5 ($406.8/MDST)
GS&A	34.0	
Freight Out	22.0	
Total Cost of Sales		56.0
● Total Delivered Cost		504.5 ($457.6/MDST)

*Totals may not add due to rounding.

I. PRINTING AND WRITING PAPERS (cont'd)

2. Book Paper (Uncoated)

a. Basis of Models

Three economic models have been prepared for the production of book paper: from virgin fiber, secondary fiber, and a blend of both. This product is made in a range of grades to suit a variety of markets. The virgin and secondary products tend to be complementary rather than competitive; thus, we have selected a furnish for each model which does not necessarily give equal quality, and we have reflected quality differences in our selling price estimates.

For the virgin fiber model, we have used a furnish of 80% bleached hardwood and 20% bleached softwood kraft pulp. For the secondary fiber model, we have used a pulp substitute deinking mixture of 40% IBM cards, 40% white ledger, and 20% No. 1 news. In the blended model, we used a fiber furnish of 50% S/F and 50% hardwood; this assumes that the 50% replacement with S/F has the equivalent strength of the 20% softwood pulp normally used in this grade. In practice, the proportion of secondary fiber is varied to meet the quality requirements of a range of grades run to meet specific orders and customer requirements.

We have estimated the selling price of the secondary fiber product at $450/MDMT, discounted 10% from the virgin fiber price of $500/MDMT. We judge that the inclusion of No. 1 news in the blended product would not cause a noticeable deterioration of product quality and that the blended product would be sold as an essentially virgin fiber product at no discount. The sensitivity charts for these models show how changes in their selling prices affect the return on capital.

Virgin and secondary book paper products are produced in all regions of the country; the secondary fiber mills are located in metropolitan areas, with some concentration in the Northeast and North Central regions. We have chosen a Northeast location for all models as representative of existing industry patterns and offering a common basis for comparison. Regional variations can be evaluated through use of the regional data previously presented (Table IX-C-1), in combination with the sensitivity charts for each model.

The virgin and blended models are sized at 272 MDMT/day to reflect a competitive scale of operations for a new book paper machine installation. This machine would be integrated to a larger (730 ADMT/day) new pulping facility, with the excess pulp used elsewhere on site. (See Slush Pulp Cost, Section A.6.)

Since the blended model represents the book paper portion of a larger total new mill installation, it is not directly indicative of the economics or the possible advantages of adding secondary fiber capacity in a situation where existing machine capacity might be expanded.

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(See Containerboard, Section E.l.a.) We have not attempted to determine how many machines have the potential for capacity expansion, nor have we idled pulp mill capacity to compensate for replacement with S/F in the blended model. The blended model provides a framework from which the potential costs and profitability of adding incremental capacity may be determined, given the specific conditions.

For secondary book paper, we have selected capacity at 136 MDMT/day, which is quite large relative to the existing industry. It is unlikely that a mill of this size could find sufficient fiber supply at competitive cost; however, this capacity was selected as a compromise between existing conditions of capacity and fiber availability, and a scale of operations large enough to be competitive with a virgin fiber machine. Presumably, new sources of fiber would have to be developed to supply a mill of this scale.

b. Comparative Economics

Table IX-I-11 summarizes the total capital, delivered cost, and return on capital for the three book paper models. Total fixed capital for the virgin and blended models of $73 million and $63 million respectively includes papermaking, deinking for the blended model, and an allocation of the capital costs for bleached kraft slush pulp production. On-site power generation is included for both by virtue of their integration to a larger pulping facility.

Total fixed capital for the secondary fiber model of $32 million is based on a single machine and includes pulp substitute deinking. It does not include on-site power generation, as the total steam requirements are below the minimum we have established for on-site power. (See Section C.2.d.) The total capital requirements for secondary book paper are lower than for either the virgin or blended models; however, the blended model has the lowest investment per daily ton, because its economical scale of deinking and total operations offset the allocated pulp mill capital costs.

Since the secondary fiber requirements for the blended model are the same as for the secondary fiber model, they are unlikely to be met for a new mill under existing industry conditions. Its capital advantages due to scale of deinking operations can be realized only if new sources of pulp substitute deinking fiber are developed. The implications of the differences in capital requirements will be discussed in the profitability analysis which follows.

The delivered cost of secondary book paper at $438.9/MDMT is higher than either the virgin product at $322.6 or the blended product at $366.9. It has the highest raw material cost of the three models because of the high cost of pulp substitute deinking grades relative to virgin fiber pulp. (The effect of fiber raw material cost on total delivered cost is clearly indicated in Figure IX-I-14.) In addition, the high conversion and capital-related costs associated with its small scale of operation, and the higher costs of a nonintegrated operation highlighted by a relative sensitivity to energy cost, increase the delivered cost of the secondary fiber model relative to the other two. The high cost of pulp substitute deinking grades of secondary fiber relative to virgin fiber hold the operating costs for both the blended and secondary models above those of the virgin fiber model, even at the low end of the secondary fiber cost range.

The most attractive pre-tax return on fixed capital is for the virgin fiber model (21.8%). However, the lower fixed capital required by the blended model makes it almost as attractive at 19.0%, despite its higher delivered cost. Figure IX-I-15 shows that secondary fiber at the low end of its cost range would make the return on the blended model about equal to that of the virgin model; however, as stated earlier, sufficient secondary fiber to support the blended model is probably not available.

For the secondary fiber model, low-cost fiber, increased scale of operations, and elimination of the selling price differential would all be required before it could have a return on capital as attractive as the virgin or blended fiber models, even though the magnitude of its capital requirement is the lowest of the three. The key to making the secondary fiber model more attractive and increasing the ROI for the blended model is the availability of a sufficient quantity of secondary pulp substitute fiber at a relatively low and stable cost.

We have included an operating cost estimate only for one additional model, a nonintegrated virgin fiber mill using market pulp as the fiber raw material. Table IX-I-18 compares this model with the 100% secondary fiber model. The costs for the virgin fiber model are based on the same capacity as the secondary fiber model, with market pulp substituted for secondary fiber and corresponding reductions in conversion and capital costs.

Thus, the nonintegrated virgin fiber model represents a new single-machine installation. Since this is a hypothetical case not directly representative of either the existing industry or probable capacity expansions, we consider it unrealistic to calculate its sensitivity and profitability. Our intent in including it is to provide a comparison on an equivalent basis of high-grade pulp substitute deinking waste papers and market pulp as alternative fiber sources for nonintegrated papermaking.

The nonintegrated virgin fiber model provides a framework for estimating actual mill costs, but one must keep in mind that the nonintegrated paper industry has no new or recent installations, and that its production is not accurately characterized by a single-machine operation.

The total delivered cost of $518.1/MDMT and the raw material cost of $322.8/MDMT for the nonintegrated virgin fiber model compare with a delivered cost of $438.9 and a raw material cost of $216.7 for secondary fiber. These differences are due to fiber source alone and would also exist at other levels of actual operating cost if the costs of conversion, capital, and sales differed from those of our models. The fiber cost differences readily explain the high cost and extensive utilization of high-grade pulp substitute deinking secondary fiber sources.

Accordingly, the existing nonintegrated paper mills could provide a ready market, even at reduced product selling prices, if new sources of these secondary fiber grades could be developed. Utilization would remain high at much greater secondary fiber tonnages than presently generated, so long as market pulp prices were at a level where our comparison is valid.

TABLE IX-I-11

ECONOMIC COMPARISON OF UNCOATED BOOK PAPER MANUFACTURE (ROLLS)

Functional Group	Printing and Writing Papers		
Grade	Book, Uncoated		
Basis Weight (g/m^2)	70 (47 lbs/3300 sq ft)		
Fiber Furnish	100% Virgin	100% Secondary	50% Virgin 50% Secondary
Plant Size (MT/Day)	272	136	272
Plant Location	Northeast	Northeast	Northeast
Plant Specifics	Integrated	Nonintegrated	Integrated
Total Fixed Capital* ($ Million)	73	32	63
($000/Daily Ton)	268	236	231
Total Delivered Cost ($/MDMT)	322.6	438.9	366.9
Raw Materials ($/MT, delivered)	168.6	216.7	196.4
Conversion ($/MT)	55.8	111.8	66.4
Capital-Related ($/MT)	34.2	54.4	40.1
Sales Cost (less freight) ($/MT)	34.0	34.0	34.0
Freight in ($/MT Product)**	15.4	18.4	16.6
Freight out ($/MT Product)	30.0	22.0	30.0
Selling Price ($/MDMT)	500	450	500
Return on Fixed Capital,* pre-tax (%)	21.8	1.6	19.0

* Including pulping

** Not included in total delivered cost

TABLE IX-I-12

DESIGN BASIS

Functional Group	Printing, Writing, & Related	Process	Integrated to bleached kraft
Grade	Book paper, uncoated	Fiber Furnish	100% virgin bleached kraft slush pulp (20% SW, 80% HW)
Basis Weight	70 g/m^2 (47 lb/3300 sq ft)	Pulp Yield	n.a.
Production	272 MDMT/day; 90,000 MDMT/yr (rolls)	Mill Location	Northeast
Net Operating Days	330/yr	Boundary Limits	Transfer of slush pulp through paper making

CAPITAL REQUIREMENTS* ($000)

Physical Plant	36,700	
Other Fixed Capital	3,700	
Total Fixed Capital		40,000
Working Capital		7,000
Total Capital Required		47,000

ENERGY REQUIREMENTS (per MDMT)

	Steam (kg)	Power (kWh)
Stock Preparation	–	150
Paper Making	3,600	200
Effluent Treatment	–	20
Misc. & Auxiliaries	600	20
Total	4,200	390

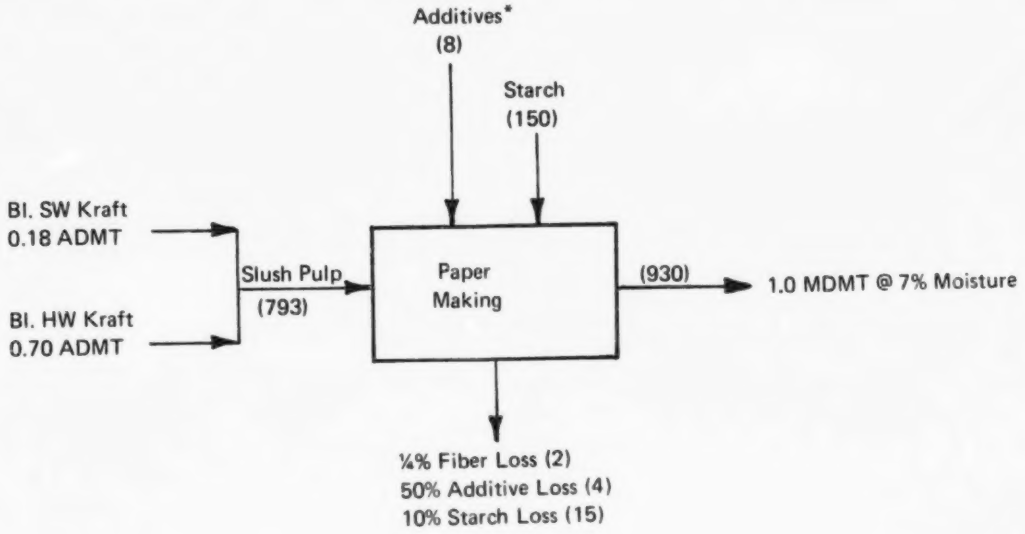
OPERATING COST* ($/MDMT)

Fiber Furnish	125.1	
Other Raw Materials	43.5	
Total Raw Materials Cost		168.6
Labor + Fringe @ 32% of Hourly Rate	14.3	
Supplies	16.5	
Energy	18.4	
Factory Overhead	6.5	
Total Conversion Costs		55.8
Capital-Related Costs		34.2
• Total Factory Operating Cost		258.6 ($234.6/ MDST)
GS&A	34.0	
Freight Out	30.0	
Total Cost of Sales		64.0
• Total Delivered Cost		322.6 ($292.7/ MDST)

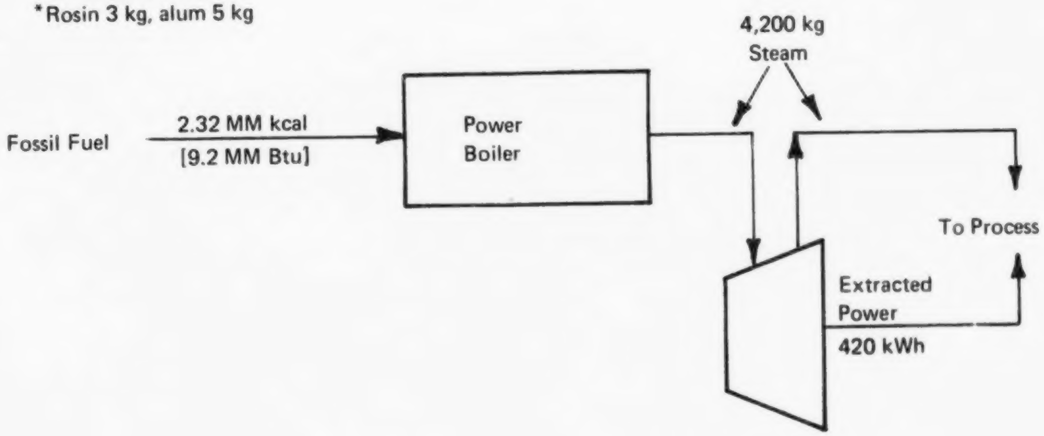
*Totals may not add due to rounding.

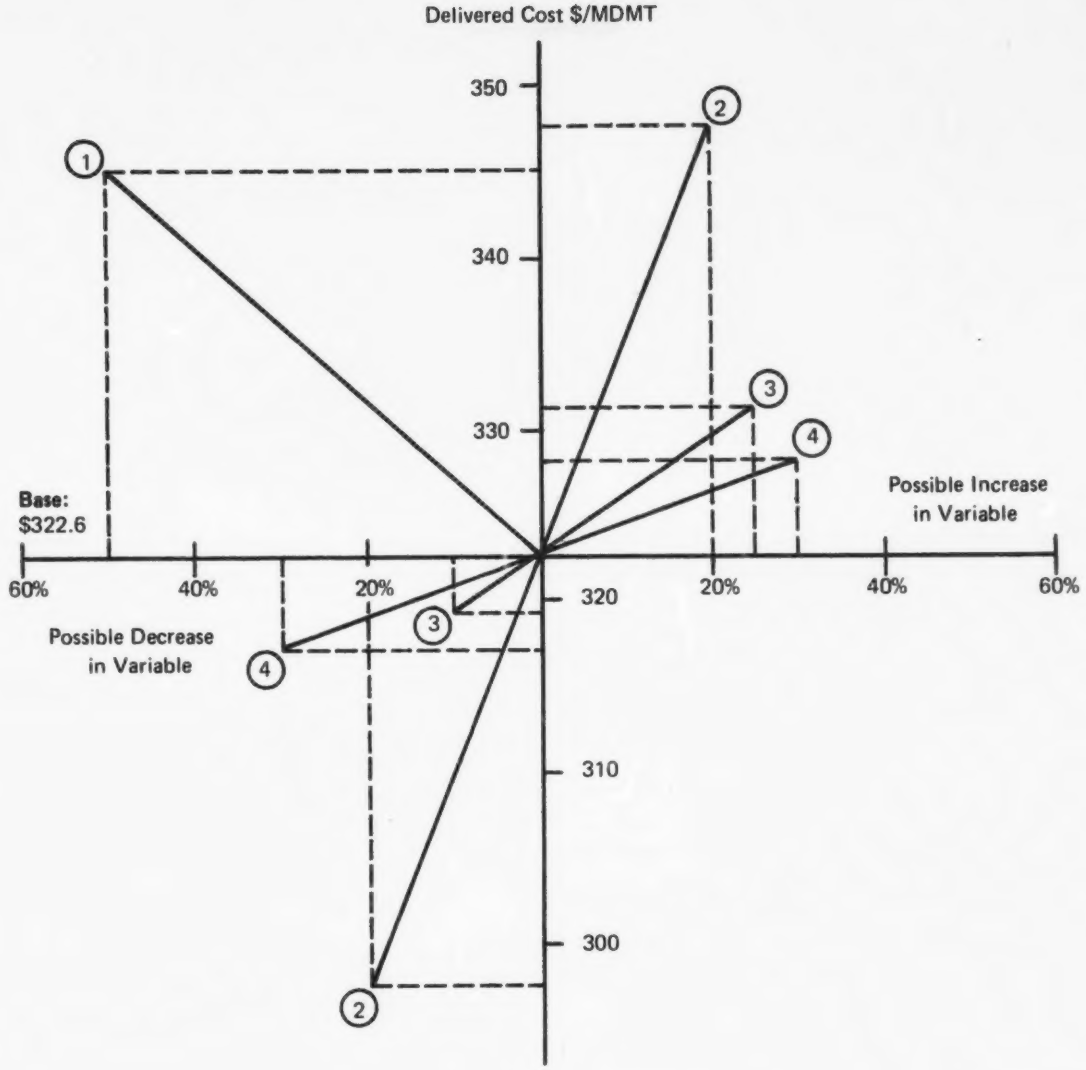
FIGURE IX-I-10

MATERIAL AND ENERGY BALANCE
(Basis: 1.0 MDMT book paper, rolls)


Additives*
(8)
Starch
(150)
Bl. SW Kraft
0.18 ADMT
Bl. HW Kraft
0.70 ADMT
Slush Pulp
(793)
Paper
Making
(930)
1.0 MDMT @ 7% Moisture
¼% Fiber Loss (2)
50% Additive Loss (4)
10% Starch Loss (15)

( ) Indicates BD kg
*Rosin 3 kg, alum 5 kg


4,200 kg
Steam
Fossil Fuel
2.32 MM kcal
[9.2 MM Btu]
Power
Boiler
To Process
Extracted
Power
420 kWh



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+ 0, −50	272	272	136
2. Delivered Cost of Fiber,* $/ADMT	+20, −20	144	173	115
3. Fixed Capital, $ Million	+25, −10	40	50	36
4. Cost of Energy, $/MMBtu	+30, −30	2.0	2.6	1.4

*Average Slush Pulp Cost

FIGURE IX–I–11 SENSITIVITY OF THE MANUFACTURING COST OF UNCOATED BOOK PAPER (VIRGIN) TO KEY VARIABLES

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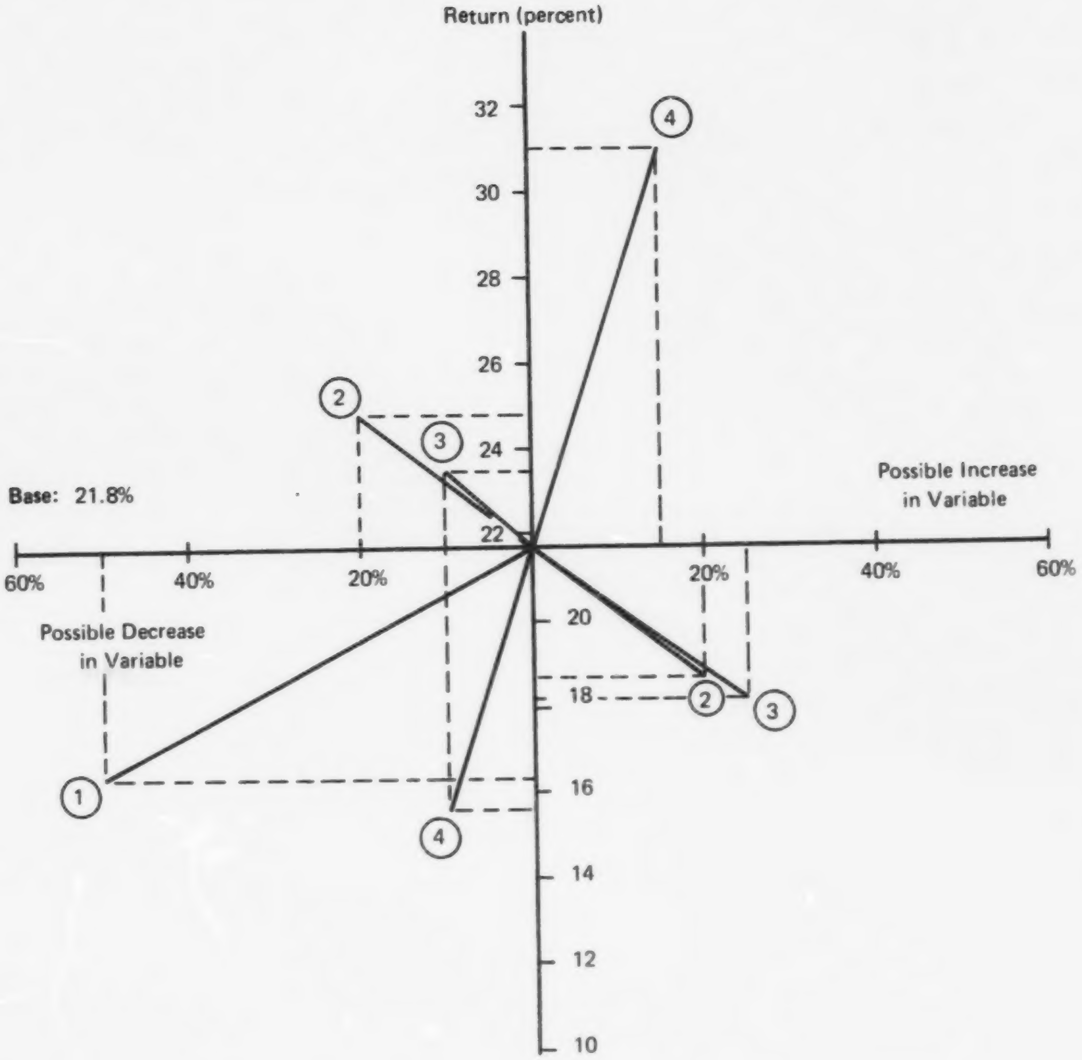


KEY VARIABLES		Percent Variation	Best Guess	Possible High	Possible Low
1.	Scale of Operations,** MTPD	+ 0, –50	272	272	136
2.	Delivered Cost of Fiber,* $/ADMT	+20, –20	144	173	115
3.	Fixed Capital,** $ Million	+25, –10	40	50	36
4.	Selling Price, $/MDMT	+15, –10	500	575	450

*Average Slush Pulp Cost

**Variation applies to papermaking operation only; allocated fixed capital for pulp manufacture is assumed constant at $33 million.

FIGURE IX–I–12 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF UNCOATED BOOK PAPER (VIRGIN) TO KEY VARIABLES

TABLE IX-I-14

DESIGN BASIS

Functional Group	Printing, Writing, & Related	Process	S/F pulping and de-inking
Grade	Book paper, uncoated	Fiber Finish	100% S/F
Basis Weight	70 g/m^2 (47 lb/3300 sq ft)	Pulp Yield	82% of AD secondary fiber to MD paper
Production	136 MDMT/day; 45,000 MDMT/yr (Rolls)	Mill Location	Northeast
Net Operating Days	330/yr	Boundary Limits	S/F preparation through paper making

CAPITAL REQUIREMENTS*
($000)

Physical Plant	29,300	
Other Fixed Capital	2,900	
Total Fixed Capital		32,000
Working Capital		5,000
Total Capital Required		37,000

ENERGY REQUIREMENTS
(per MDMT)

	Steam (kg)	Power (kWh)
De-inking	500	300
Stock Preparation	–	150
Paper Making	3,600	200
Effluent Treatment	–	20
Misc. & Auxiliaries	700	60
Total	4,800	730

*Totals may not add due to rounding

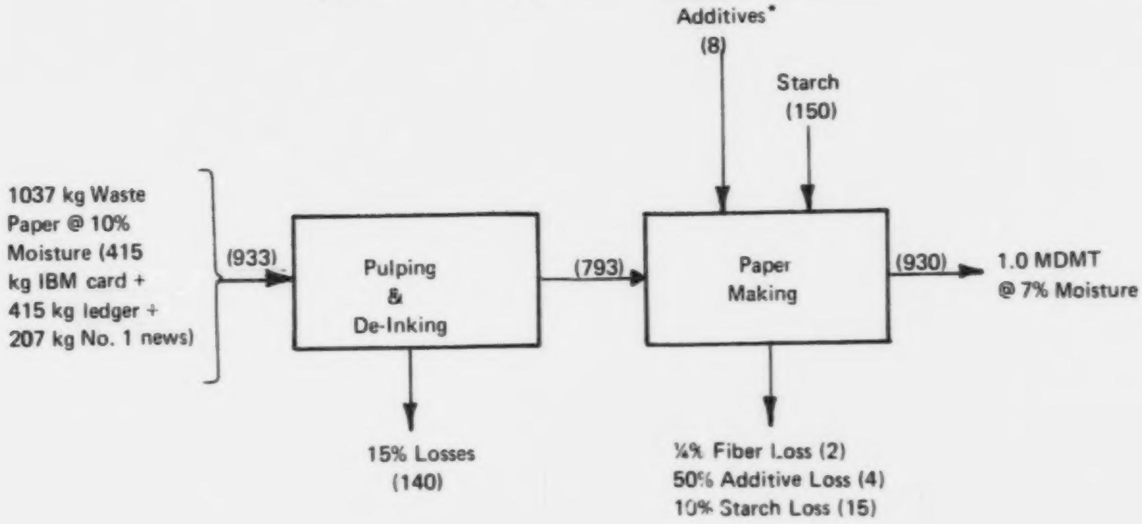
OPERATING COST*
($/MDMT)

Fiber Furnish	167.5	
Other Raw Materials	49.3	
Total Raw Materials		216.7
Labor + Fringe @ 32% of Hourly Rate	33.1	
Supplies	21.5	
Energy	36.5	
Factory Overhead	20.7	
Total Conversion Costs		111.8
Capital-Related Costs		54.4
• Total Factory Operating Cost		382.9 ($347.4/ MDST)
GS&A	34.0	
Freight Out	22.0	
Total Cost of Sales		56.0
• Total Delivered Cost		438.9 ($398.2/ MDST)

FIGURE IX-I-13

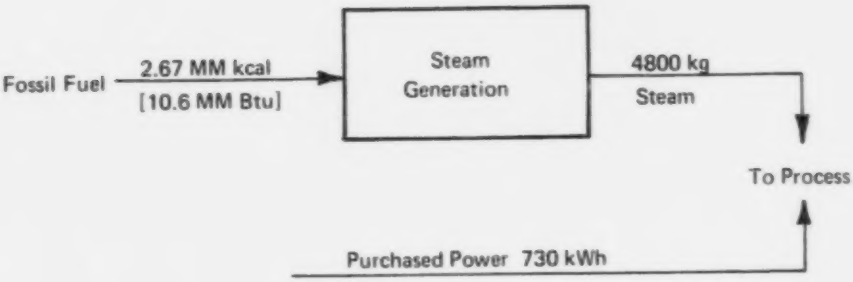
MATERIAL AND ENERGY BALANCE

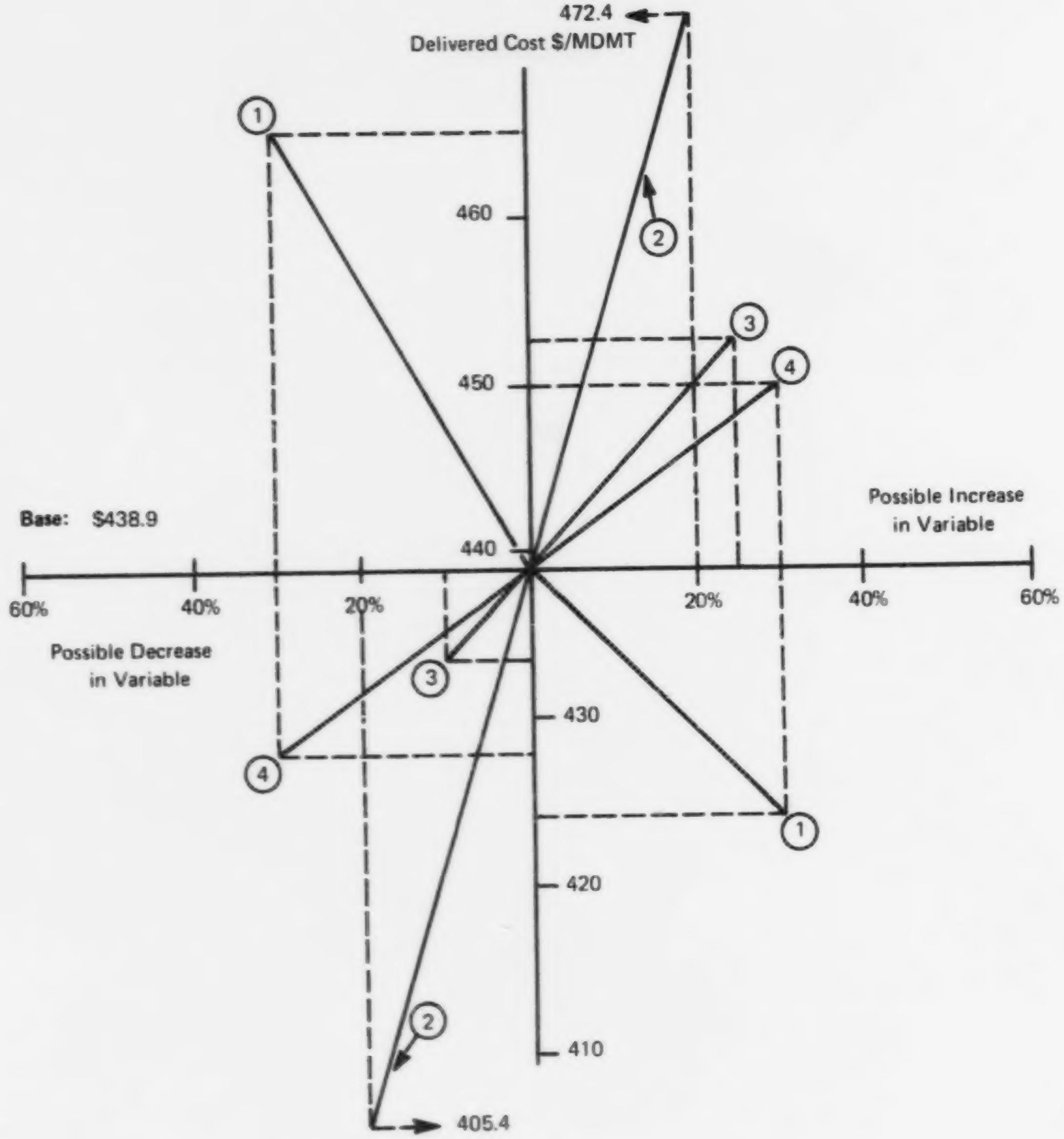
(Basis: 1.0 MDMT book paper, rolls)


Additives*
(8)
Starch
(150)
1037 kg Waste Paper @ 10% Moisture (415 kg IBM card + 415 kg ledger + 207 kg No. 1 news)
(933)
Pulping & De-Inking
(793)
Paper Making
(930)
1.0 MDMT @ 7% Moisture
15% Losses
(140)
¼% Fiber Loss (2)
50% Additive Loss (4)
10% Starch Loss (15)

( ) Indicates BD kg

* Rosin 3 kg, alum 5 kg


Fossil Fuel
2.67 MM kcal
[10.6 MM Btu]
Steam Generation
4800 kg
Steam
To Process
Purchased Power 730 kWh



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+30, −30	136	177	95
2. Delivered Cost of Fiber,* $/ADMT	+20, −20	164	197	131
3. Fixed Capital, $ Million	+25, −10	32	40	29
4. Cost of Energy, $/MMBtu	+30, −30	2.0	2.6	1.4

*Composite Average Secondary Fiber Cost

FIGURE IX–I–14 SENSITIVITY OF THE MANUFACTURING COST OF UNCOATED BOOK PAPER (SECONDARY) TO KEY VARIABLES

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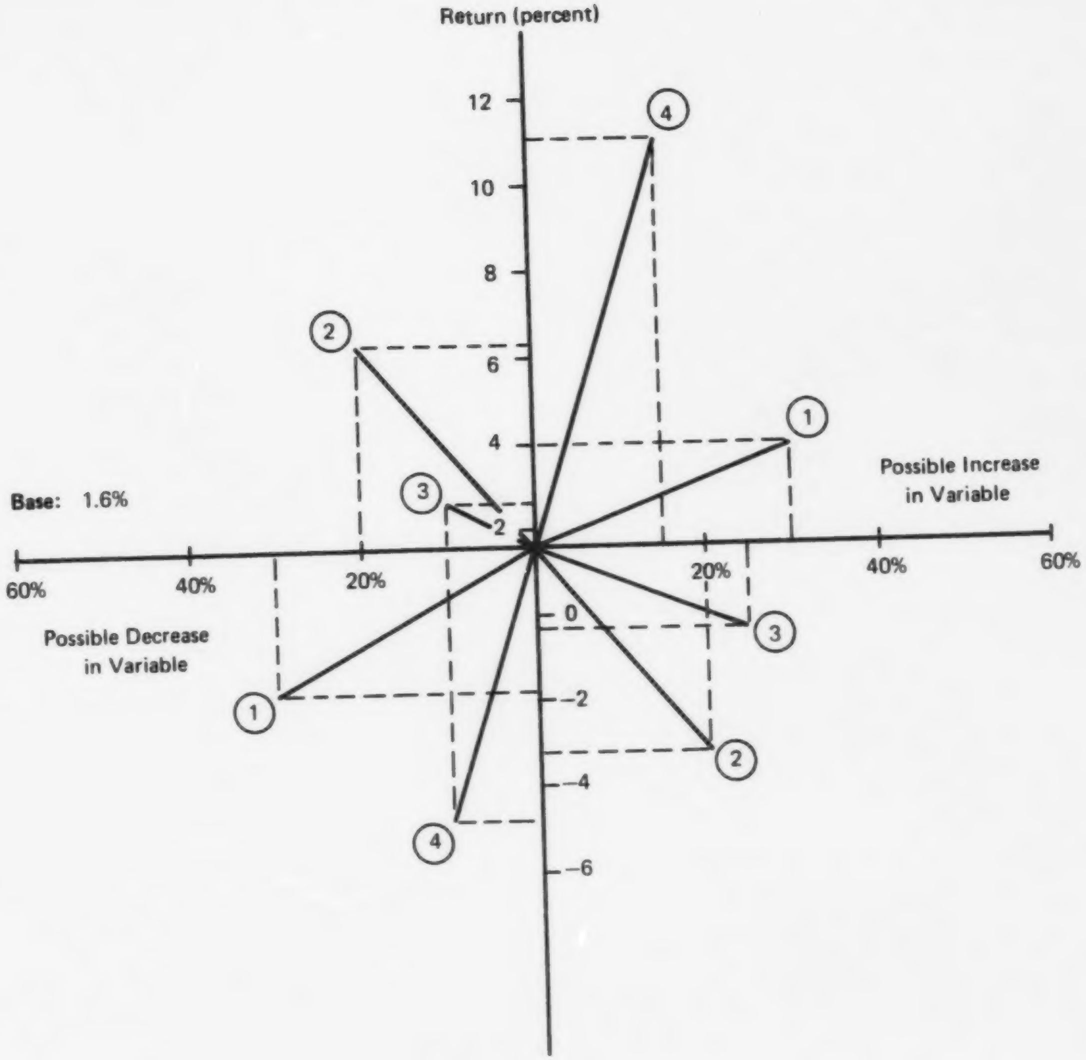

KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+30, −30	136	177	95
2. Delivered Cost of Fiber,* $/ADMT	+20, −20	164	197	131
3. Fixed Capital, $ Million	+25, −10	32	40	29
4. Selling Price, $/MDMT	+15, −10	450	518	405

*Composite Average Secondary Fiber Cost

FIGURE IX–I–15 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF UNCOATED BOOK PAPER (SECONDARY) TO KEY VARIABLES

TABLE IX-I-16

DESIGN BASIS

Functional Group	Printing, Writing, & Related	Process	Pulp substitute de-inking, integrated to bleached kraft
Grade	Book paper, uncoated	Fiber Furnish	50% virgin bl kraft slush pulp, 50% S/F
Basis Weight	70 g/m^2 (47 lb/3300 sq ft)	Pulp Yield	82% MD paper to AD S/F
Production	272 MDMT/day; 90,000 MDMT/yr (rolls)	Mill Location	Northeast
Net Operating Days	330/yr	Boundary Limits	Transfer of slush pulp and S/F preparation through paper making

CAPITAL REQUIREMENTS* (\$000)

Physical Plant	42,900	
Other Fixed Capital	4,300	
Total Fixed Capital		47,000
Working Capital		8,000
Total Capital Required		55,000

ENERGY REQUIREMENTS (per MDMT)

	Steam (kg)	Power (kWh)
De-inking	250	150
Stock Preparation	–	150
Paper Making	3,600	200
Effluent Treatment	–	20
Misc. & Auxiliaries	650	40
Total	4,500	560

OPERATING COST* (\$/MDMT)

Fiber Furnish	149.6	
Other Raw Materials	47.0	
Total Raw Materials Cost		196.4
Labor + Fringe @ 32% of Hourly Rate	17.6	
Supplies	18.3	
Energy	22.5	
Factory Overhead	7.9	
Total Conversion Costs		66.4
Capital-Related Costs		40.1
• Total Factory Operating Cost		302.9 (\$274.8/MDST)
GS&A	34.0	
Freight Out	30.0	
Total Cost of Sales		64.0
• Total Delivered Cost		366.9 (\$332.9/MDST)

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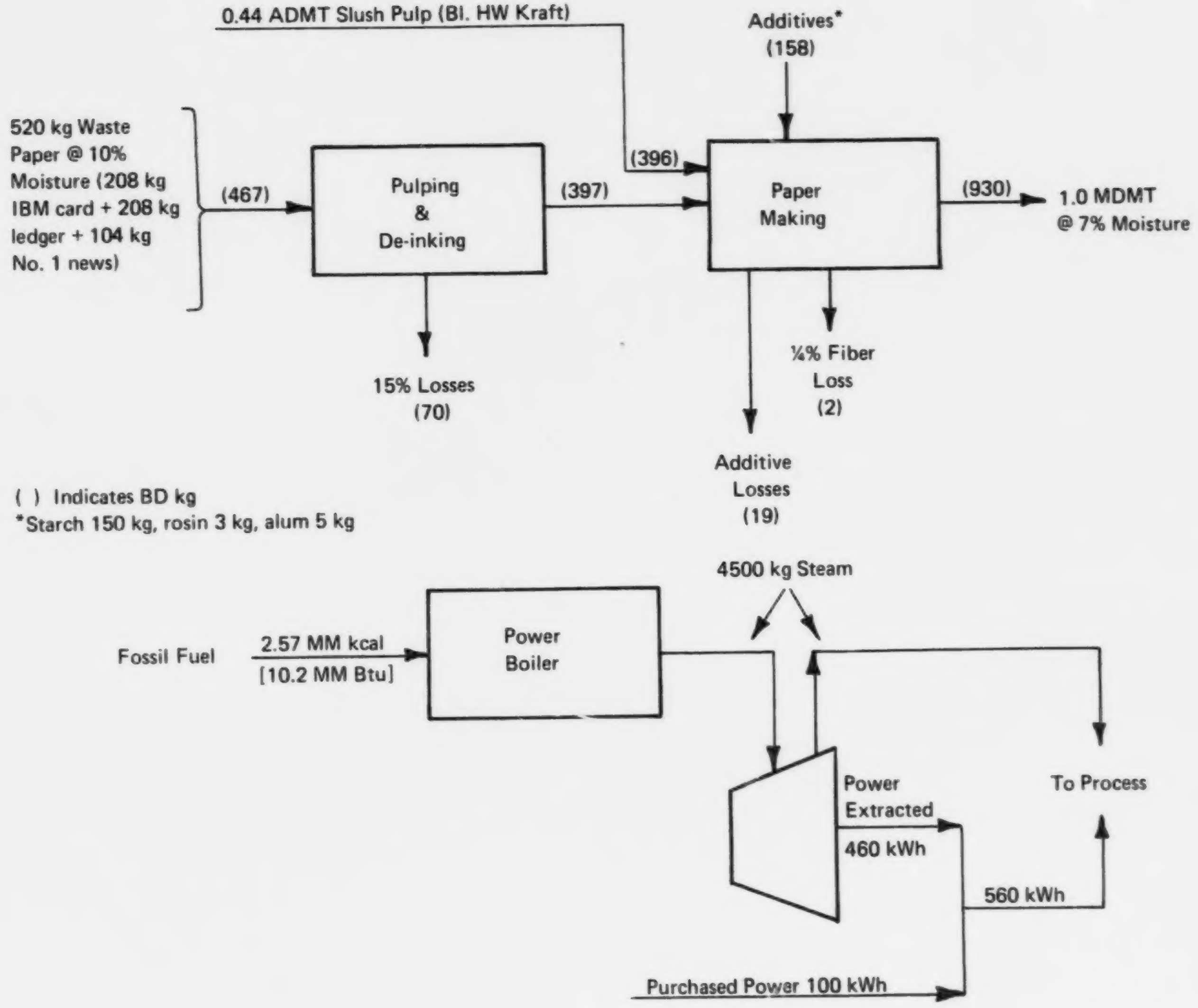
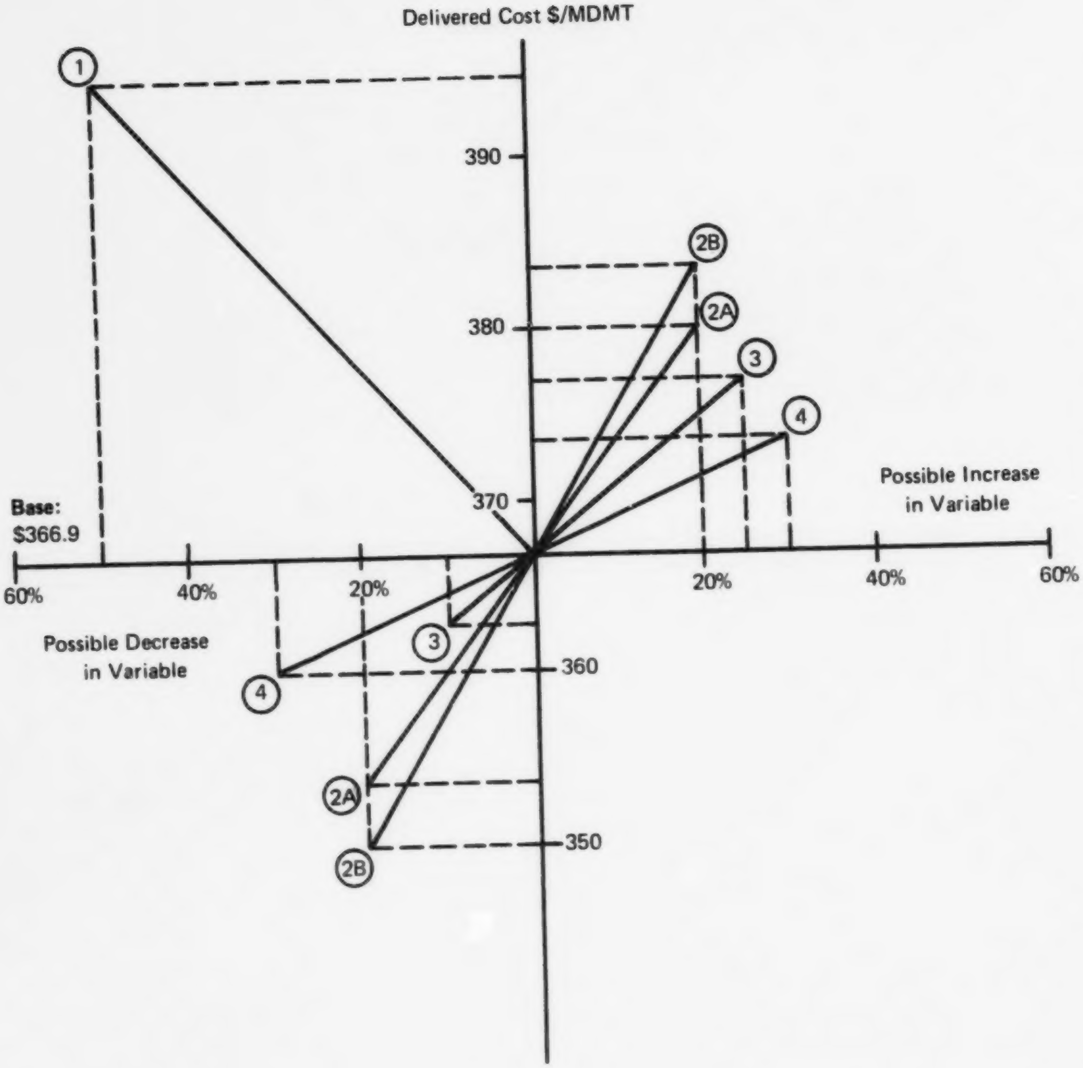
*Totals may not add due to rounding.

FIGURE IX-16

MATERIAL AND ENERGY BALANCE

(Basis: 1.0 MDMT book paper, rolls)


0.44 ADMT Slush Pulp (Bl. HW Kraft)
Additives*
(158)
520 kg Waste Paper @ 10% Moisture (208 kg IBM card + 208 kg ledger + 104 kg No. 1 news)
(467)
Pulping & De-inking
(397)
(396)
Paper Making
(930)
1.0 MDMT @ 7% Moisture
15% Losses
(70)
¼% Fiber Loss
(2)
Additive Losses
(19)
( ) Indicates BD kg
*Starch 150 kg, rosin 3 kg, alum 5 kg
4500 kg Steam
Fossil Fuel
2.57 MM kcal
[10.2 MM Btu]
Power Boiler
Power Extracted
460 kWh
To Process
560 kWh
Purchased Power 100 kWh



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+ 0, −50	272	272	136
2. A Delivered Cost of Fiber,* $/ADMT	+20, −20	137	164	109
B		163	197	131
3. Fixed Capital, $ Million	+25, −10	47	59	42
4. Cost of Energy, $/MMBtu	+30, −30	2.0	2.6	1.4

*2A—Virgin (Average Slush Pulp Cost), 2B—Secondary Fiber (Average)

FIGURE IX–I–17 SENSITIVITY OF THE MANUFACTURING COST OF UNCOATED BOOK PAPER (BLENDED) TO KEY VARIABLES

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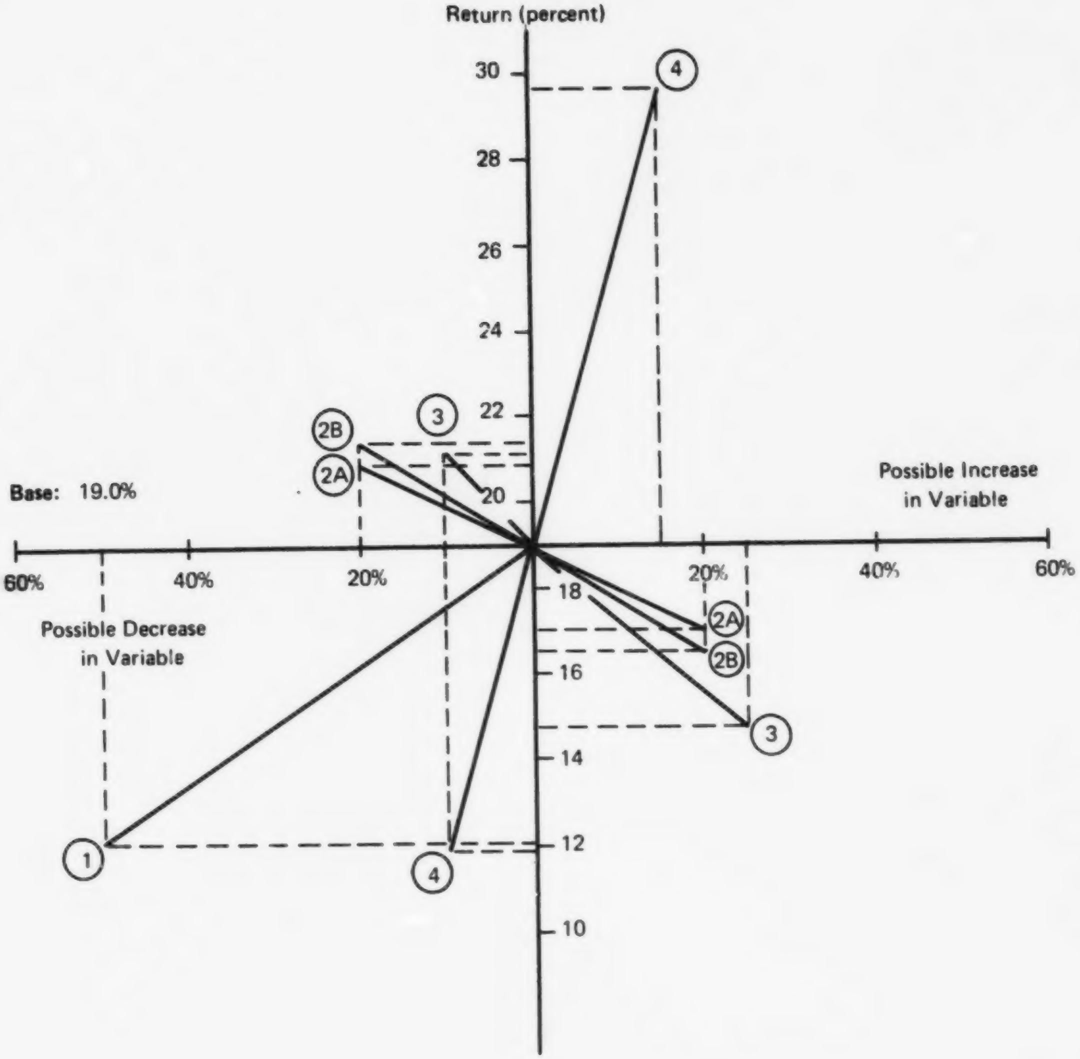


KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations,** MTPD	+ 0, −50	272	272	136
2. A B Delivered Cost of Fiber,* $/ADMT	+20, −20	137 163	164 197	109 131
3. Fixed Capital,** $ Million	+25, −10	47	59	42
4. Selling Price, $/MDMT	+15, −10	500	575	450

*2A—Virgin (Average Slush Pulp Cost), 2B—Secondary Fiber (Average)

**Variation applies to papermaking operation only; allocated fixed capital for pulp manufacture is assumed constant at $16 million.

FIGURE IX–I–18 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF UNCOATED BOOK PAPER (BLENDED) TO KEY VARIABLES

TABLE IX-I-18

ECONOMIC COMPARISON OF BOOK PAPER, UNCOATED (ROLLS) MANUFACTURED FROM VIRGIN VS. SECONDARY FIBER (NONINTEGRATED MILL)

Functional Group	Printing & Writing Paper	
Grade	Book, Uncoated	
Basis Weight (g/m^2)	70 (47 lb/3300 sq ft)	
Fiber Furnish	100% Virgin	100% Secondary
Plant Size (MT/day)	136	136
Plant Location	Northeast	Northeast
Plant Specifics	Nonintegrated	Nonintegrated
Total Fixed Capital ($/Million)	26	32
Total Delivered Cost ($/MDMT)	518.1	438.9
Raw Materials ($/MT delivered)	322.8	216.7
Conversion ($/MT)	94.9	111.8
Capital-Related ($/MT)	44.4	54.4
Sales Cost (less freight)($/MT)	34.0	34.0
Freight In ($/ MT) *	19.1	18.4
Freight Out ($/MT)	22.0	22.0
Selling Price ($/MT)	500	450
Return on Fixed Capital, pre-tax (%)	- 3.0	1.6

*Not included in total delivered cost

TABLE IX-I-19

DESIGN BASIS

Functional Group	Printing & Writing	Process	Market Pulp
Grade	Uncoated book paper	Fiber Furnish	100% virgin (market pulp)
Basis Weight	70 g/m^2 (47 lb/3300 sq ft)	Pulp Yield	n.a.
Production	136 MDMT/day; 45,000 MDMT/yr (rolls)	Mill Location	Northeast
Net Operating Days	330/yr	Boundary Limits	Nonintegrated; purchased market pulp through papermaking

CAPITAL REQUIREMENTS* ($000)

Physical Plant	23,800	
Other Fixed Capital	2,400	
Total Fixed Capital		26,000
Working Capital		5,000
Total Capital Required		31,000

ENERGY REQUIREMENTS (per MDMT)

Steam (kg)	Power (kWh)
4,300	580

OPERATING COST* ($/MDMT)

Fiber Furnish	279.3	
Other Raw Materials	43.5	
Total Raw Materials Cost		322.8
Labor + Fringe @ 32% of Hourly Rate	27.8	
Supplies	19.4	
Energy	30.6	
Factory Overhead	17.1	
Total Conversion Costs		94.9
Capital-Related Costs		44.4
• Total Factory Operating Cost		462.1 ($419.1/ MDST)
GS&A	34.0	
Freight Out	22.0	
Total Cost of Sales		56.0
• Total Delivered Cost		518.1 ($469.9/ MDST)

*Totals may not add due to rounding.

J. INDUSTRIAL PACKAGING, CONVERTING & MISCELLANEOUS PAPERS

1. Unbleached Kraft Bag and Tube Papers

a. Basis of Models

Three economic models have been prepared for unbleached kraft bag paper and three for unbleached kraft tube paper--production from virgin fiber, secondary fiber, and a blend of both. The categories of bag papers and tube papers include a wide variety of product grades and qualities designed to meet specific end-use requirements. In setting the fiber furnish and manufacturing conditions for both the bag and tube paper categories, we have selected an intermediate quality grade. At this intermediate quality level, or for lower product grades, secondary bag and tube papers would compete with the virgin products on an equivalent quality and selling price basis. We have reflected this in our estimates by using a uniform selling price for the virgin, secondary, and blended fiber models of bag paper, and the same is true of the tube paper models.

The above does not apply to higher quality products; 100% secondary fiber would not be suitable for the better grades of either bag or tube paper. Over the quality range possible with 100% secondary fiber, however, it is a competitive product that sells without price discounting. For the grades selected, we have estimated a price of $225/MDMT for bag paper and $210 for tube paper.

A sensitivity chart for each model shows how variations in these selling prices affect the return on capital.

For the virgin fiber models of both products, we have used a 100% unbleached softwood kraft slush pulp furnish. For the secondary fiber models, we have used a furnish of 20% double kraft lined corrugated cuttings and 80% unbleached kraft pulp substitute. The percentage of corrugated cuttings is the maximum that can be tolerated without deterioration of product quality. The blended model for bag paper uses the same secondary fiber mix for 30% of the fiber furnish and unbleached softwood kraft slush pulp for the other 70%; in the blended model for tube paper, the percentages are reversed.

The higher proportion of secondary fiber in the tube paper furnish reflects the fact that the higher basis weights typical of tube paper grades could accommodate a higher proportion of secondary fiber with no deterioration of product quality. (Of course, the required quantity of secondary fiber might not be available at competitive cost under existing industry conditions.) In practice, the relative proportions in the secondary fiber mix and the total fraction of secondary fiber in the furnish are varied to meet the secondary fiber availability and the quality requirements of a range of grades of both bag and tube papers.

Virgin bag and tube papers are produced primarily in the South and Pacific Northwest regions. We have chosen a Southeast location as representative of existing industry patterns. Regional variations can be evaluated through use of the regional data previously presented (Table IX-C-1), in combination with the sensitivity charts for each model.

Since the major fiber source for the secondary models is converter waste, they are not limited to any particular regions. However, a metropolitan area is required that has sufficient unbleached kraft converting activity to provide the amount of fiber needed. We have chosen a Northeast location for both secondary bag and tube papers as representative of existing industry patterns. Regional variations can be determined through use of the regional data (Table IX-C-1) and sensitivity charts.

The virgin and blended fiber models for bag paper are sized at 210 MDMT/day and for tube paper at 240 MDMT/day to reflect present industry characteristics and the economics of producing these grades on new machines. The machines for all of these models are assumed to be integrated to a larger (730 ADMT/day) new pulping facility, with the excess slush pulp used elsewhere on-site. (See Slush Pulp Cost, Section A.6.)

Since the blended models represent the bag or tube paper portion of a larger total new mill installation, they are not directly indicative of the economics or the possible advantages of adding secondary fiber capacity in a situation where existing machine capacity might be expanded. (See Containerboard, Section E.1.a.) We have not attempted to determine how many machines have the potential for capacity expansion, nor have we idled pulp mill capacity to compensate for replacement with secondary fiber in the blended models. These models provide a framework from which the potential costs and profitability of adding incremental capacity may be determined, given the specific conditions.

For secondary bag and tube paper, we have selected capacity at 120 and 136 MDMT/day respectively. We believe these capacities to be representative of existing industry characteristics of machine capacity and fiber availability. However, machine capacities are not limited to these levels by technical considerations.

b. Comparative Economics

Tables IX-J-1 and IX-J-11 summarize the total capital, delivered cost, and return on capital for the bag paper and tube paper models. Total fixed capital of $52 million and $46 million respectively for the virgin and blended bag paper models, and of $55 million and $37 million respectively for the virgin and blended tube paper models, includes papermaking, secondary fiber pulping for the blended models, and an allocation of the capital costs for unbleached kraft slush pulp production. On-site power generation is included for all, by virtue of their integration to a larger pulping facility.

Total fixed capital for the secondary bag paper and tube paper models of $21 million is based on a single-machine operation in each case and includes secondary fiber pulping. It does not include on-site power generation, as the total steam requirements are below the minimum we have established for on-site power. (See Section C.2.d.) The total capital requirements and investment per daily ton for secondary bag paper are lower than for either the virgin or blended models. The total capital requirements for secondary tube paper are lower than for either the virgin or blended models, but the investment per daily ton for the blended model is equal to that for the secondary model. Comparison of the capital requirements for the bag and tube paper models clearly indicates the low investment for secondary fiber pulping relative to virgin fiber pulping, as well as the advantages of increased scale of operations in investment per daily ton. The implications of these differences are discussed in the profitability analysis which follows.

The delivered cost of secondary bag paper at $263.4/MDMT is higher than either the virgin product at $199.3 or the blended product at $203.8. Similarly, the delivered cost of secondary tube paper at $250.6/MDMT is higher than either the virgin product at $189.8 or the blended product at $199.6. Both secondary fiber models have a disadvantage because of the relatively high cost of pulp substitute fiber compared with virgin fiber. The effect of fiber raw material cost on total delivered cost is clearly indicated in the sensitivity charts. In addition, the high conversion and capital-related costs associated with a small scale of operations, and the higher costs of a nonintegrated operation highlighted by a relative sensitivity to energy cost, increase the delivered costs of the secondary fiber models relative to those of the virgin or blended fiber models.

The combination of these negative effects holds the operating costs for both the secondary bag and tube paper models above the virgin or blended fiber models, even at the low end of the S/F cost range. However, the base-level blended models have only slightly higher delivered cost than the virgin fiber models, and at the low end of the secondary fiber cost range, the blended models have the lowest operating costs.

The pre-tax return on fixed capital for all these models is quite low; virgin fiber bag paper at 3.4% and virgin fiber tube paper at 2.9% are the highest. The blended fiber models at 3.2% and 2.2% respectively are almost as good. As indicated on the sensitivity charts for return on capital, if secondary fiber were at the low end of its cost range, the blended models would be slightly more attractive than the virgin fiber models.

For the secondary fiber models of bag paper and tube paper, we have omitted the sensitivity of return on capital to variations in capital and scale of operations because of the mathematical ambiguities of negative returns. Since the base-level return for both models is negative, the relationship to any single factor which has capital as a component (i.e., scale of operations or base-level fixed capital) is inverse. Return becomes a larger negative number with a decrease in fixed capital. However, the combined effect of increased scale of operations and decreased fiber cost can be inferred from the sensitivity of delivered cost (Tables IX-J -5 and IX-J-14): costs would be only a few dollars below selling price for both secondary bag and tube papers. Despite the lower magnitude of their capital requirements, the return for these secondary models would be less than for the virgin or blended models over the ranges we have considered reasonable for the various cost components.

We have included an operating cost estimate only for one additional model, a nonintegrated virgin fiber bag paper mill using market pulp as the fiber raw material. Table IX-J-18 compares this model with the 100% secondary fiber model. The costs for the virgin fiber model are based on the same capacity as the secondary fiber model and the substitution of market pulp for secondary fiber, with corresponding reductions in conversion and capital costs.

Thus, the nonintegrated virgin fiber model represents a new single-machine installation. Since this is a hypothetical case not directly representative of either the existing industry or probable capacity expansions, we consider it unrealistic to calculate sensitivity and profitability. It is included to provide a comparison on an equivalent basis of high-grade pulp waste papers and market pulp as alternative fiber sources for nonintegrated papermaking.

The nonintegrated virgin fiber model provides a framework for estimating actual mill costs, but one must keep in mind that the nonintegrated paper industry has no new or recent installations, and it is not accurately characterized by a single-machine operation.

The total delivered cost of $461.5/MDMT and the raw material cost of $317.3/MDMT for the nonintegrated virgin fiber model compare with a delivered cost of $263.4 and raw material cost of $111.4 for secondary fiber. These differences are due to fiber source alone and would also exist at other levels of actual operating cost if the costs of conversion, capital, and sales differed from those of our models. The fiber cost differences readily explain the high cost and extensive utilization of high-grade OCC converter waste.

Accordingly, the existing nonintegrated paper mills could provide a ready market if new sources of these secondary fiber grades could be developed. Utilization would remain high at much greater secondary fiber tonnages than presently generated, so long as market pulp prices were at a level where our comparison is valid.

TABLE IX-J-1

ECONOMIC COMPARISON OF UNBLEACHED KRAFT BAG PAPER MANUFACTURE

Functional Group	Industrial packaging, converting, & Misc.		
Grade	Unbleached Kraft Bag Paper		
Basis Weight (g/m^2)	93 (57 lb/3000 sq ft)		
Fiber Furnish	100% Virgin	100% S/F	70% Virgin 30% S/F
Plant Size (MT/Day)	210	120	210
Plant Location	Southeast	Northeast	Southeast
Plant Specifics	Integrated	Nonintegrated	Integrated
Total Fixed Capital* ($Million)	52	21	46
($000/Daily Ton)	248	175	219
Total Delivered Cost ($/MDMT)	199.3	263.4	203.8
Raw Materials ($/MT, delivered)	101.2	111.4	103.6
Conversion ($/MT)	42.3	89.1	43.1
Capital-Related ($/MT)	30.9	40.9	32.0
Sales Cost (less freight) ($/MT)	7.0	7.0	7.0
Freight in ($/MT Product)**	14.3	10.6	13.1
Freight out ($/MT Product)	18.0	15.0	18.0
Selling Price ($/MDMT)	225	225	225
Return on Fixed Capital*, pre-tax (%)	3.4	- 7.2	3.2

* Including pulping

** Not included in total delivered cost

Table IX-J-2

DESIGN BASIS

Functional Group	Industrial Packaging, Converting & Misc.	Process	Integrated to unbl. kraft pulp mill
Grade	Unbl. kraft bag paper	Fiber Furnish	100% unbl. SW kraft slush pulp
Basis Weight	93 g/m^2 (56 lb/3000 sq ft)	Pulp Yield	n.a.
Production	210 MDMT/day; 69,300 MDMT/yr	Mill Location	Southeast
Net Operating Days	330/yr	Boundary Limits	Transfer of slush pulp through paper making

CAPITAL REQUIREMENTS*
($000)

Physical Plant	25,000	
Other Fixed Capital	2,500	
Total Fixed Capital		28,000
Working Capital		3,000
Total Capital Required		31,000

ENERGY REQUIREMENTS
(per MDMT)

	Steam (kg)	Power (kWh)
Stock Preparation	–	220
Paper Making	4,000	100
Effluent Treatment	–	50
Misc. & Auxiliaries	600	170
Total	4,600	540

*Totals may not add due to rounding.

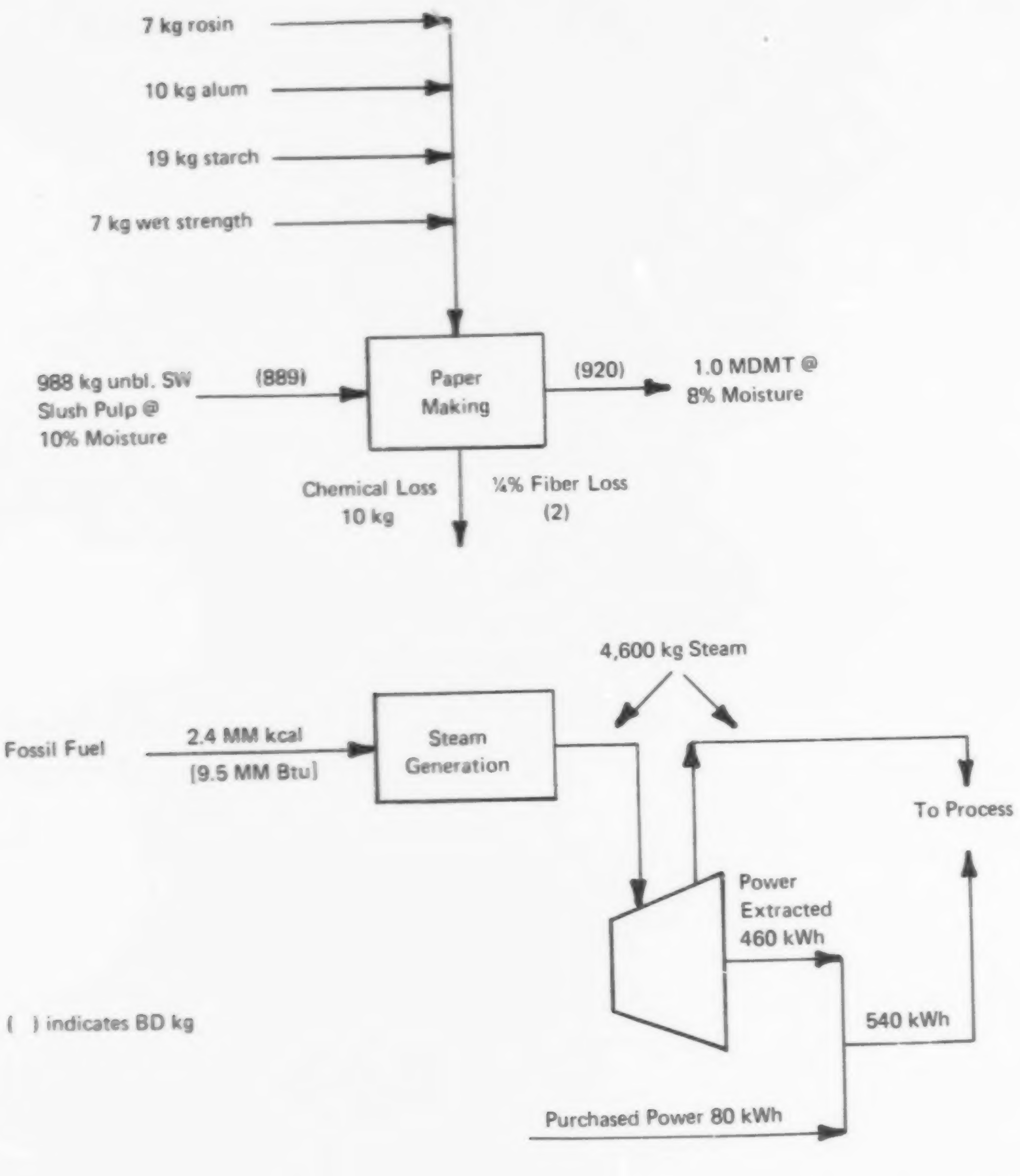
OPERATING COST*
($/MDMT)

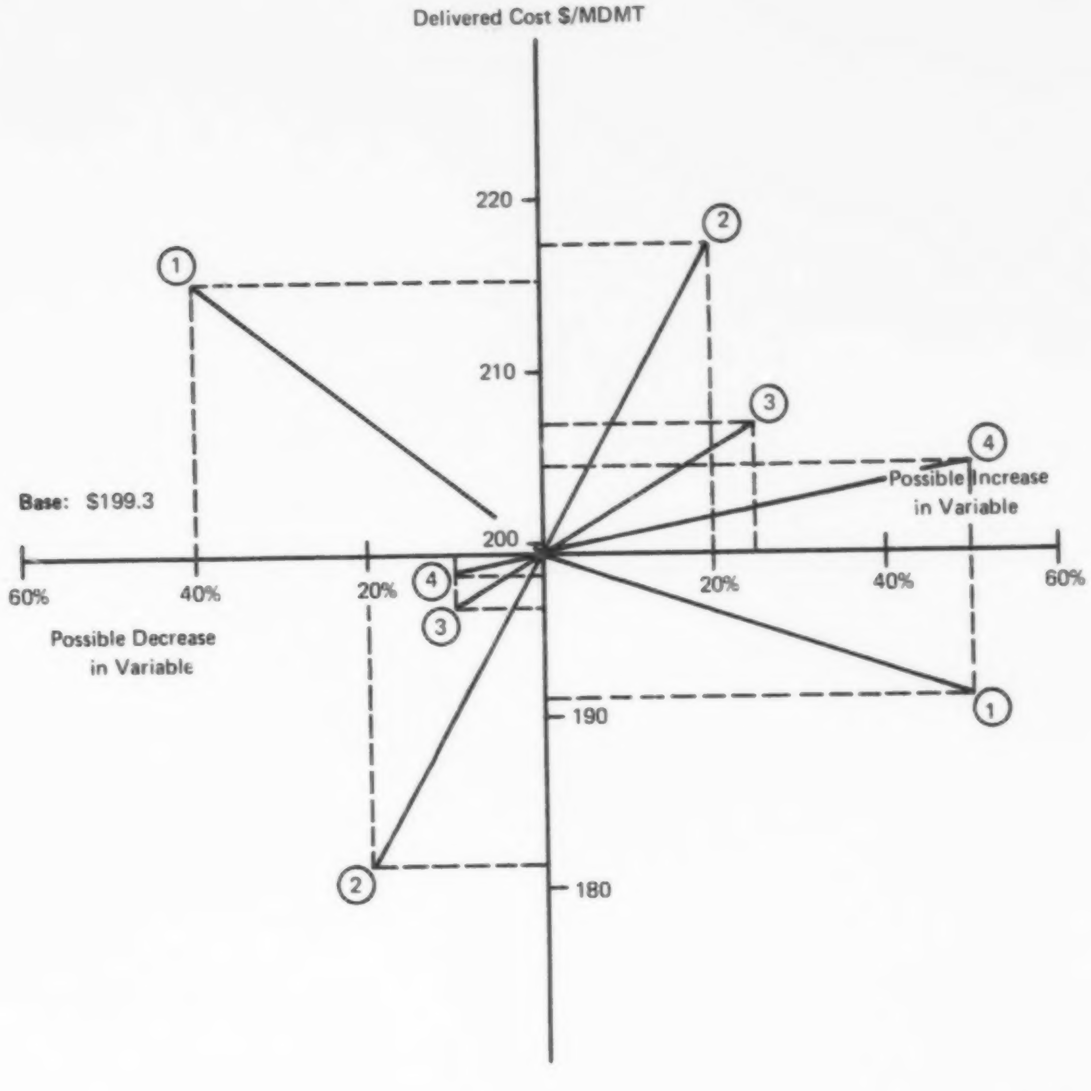
Fiber Furnish	90.2	
Other Raw Materials	11.0	
Total Raw Materials Cost		101.2
Labor + Fringe @ 32% of Hourly Rate	17.6	
Supplies	8.3	
Energy	10.5	
Factory Overhead	5.9	
Total Conversion Costs		42.3
Capital-Related Costs		30.9
• Total Factory Operating Cost		174.3 ($158.1/MDST)
GS&A	7.0	
Freight Out	18.0	
Total Cost of Sales		25.0
• Total Delivered Cost		199.3 ($180.8/MDST)

Figure IX-J-1

MATERIAL AND ENERGY BALANCE

(**Basis:** 1.0 MDMT unbleached kraft bag paper)


7 kg rosin
10 kg alum
19 kg starch
7 kg wet strength
988 kg unbl. SW Slush Pulp @ 10% Moisture
(889)
Paper Making
(920)
1.0 MDMT @ 8% Moisture
Chemical Loss 10 kg
¼% Fiber Loss (2)
4,600 kg Steam
Fossil Fuel
2.4 MM kcal
[9.5 MM Btu]
Steam Generation
To Process
Power Extracted 460 kWh
540 kWh
( ) indicates BD kg
Purchased Power 80 kWh



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+50, −40	210	315	125
2. Delivered Cost of Fiber,* $/ADMT	+20, −20	91	110	73
3. Fixed Capital, $ Million	+25, −10	28	35	25
4. Cost of Energy, $/MMBtu	+50, −10	1.0	1.5	0.9

*Slush Pulp Cost

FIGURE IX–J–2 SENSITIVITY OF THE MANUFACTURING COST OF UNBLEACHED KRAFT BAG PAPER (VIRGIN) TO KEY VARIABLES

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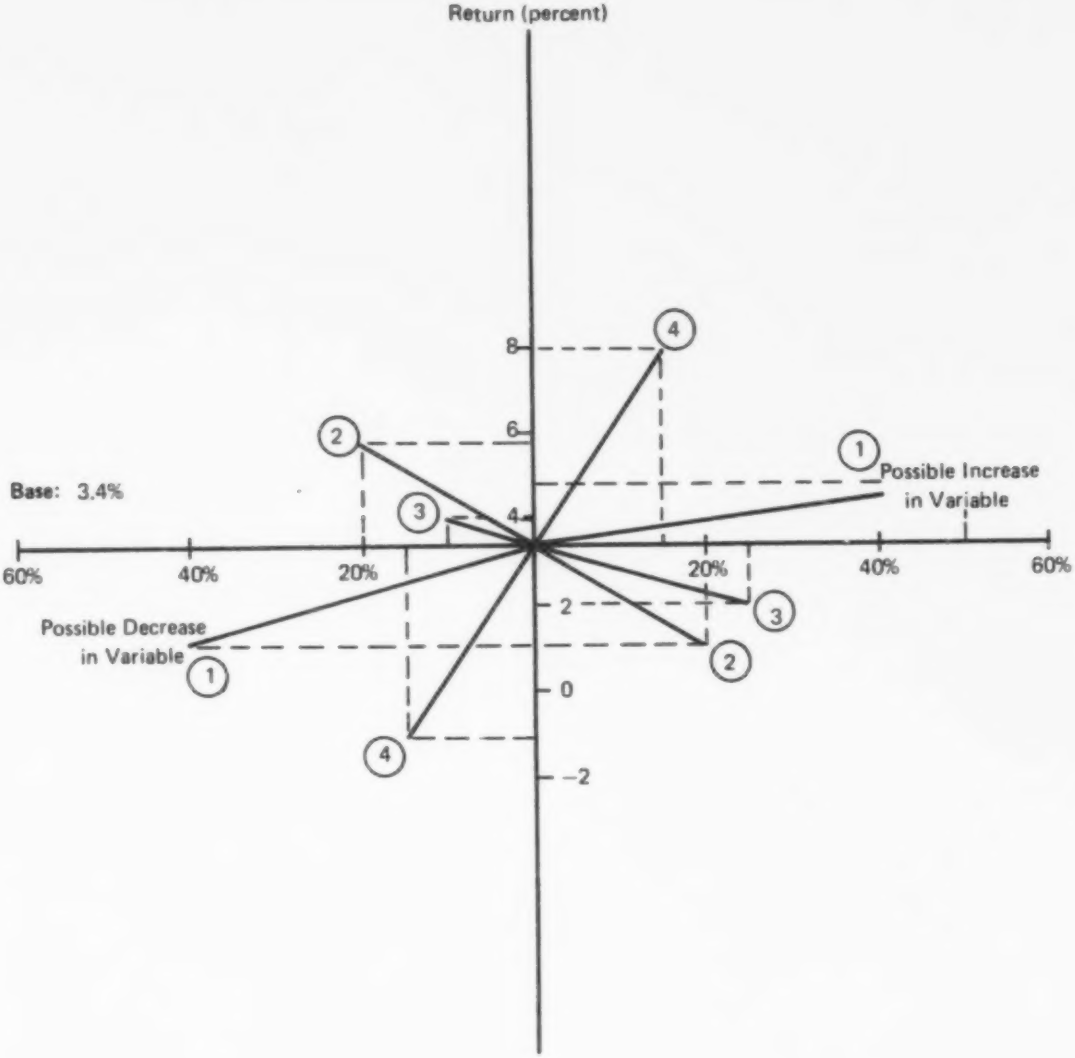


KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+50, –40	210	315	125
2. Delivered Cost of Fiber,* $/ADMT	+20, –20	91	110	73
3. Fixed Capital,** $ Million	+25, –10	28	35	25
4. Selling Price, $/MDMT	+15, –15	225	259	191

*Average Slush Pulp Cost

**Variation applies to papermaking operation only; allocated fixed capital for pulp manufacture is assumed constant at $24 million.

FIGURE IX–J–3 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF UNBLEACHED KRAFT BAG PAPER (VIRGIN) TO KEY VARIABLES

Table IX-J-4

DESIGN BASIS

Functional Group	Industrial Packaging, converting and Misc.	Process	S/F pulping
Grade	Unbl. kraft bag paper	Fiber Furnish	100% S/F (20% dbl. kraft lined corr. cuts, 80% P/S unbl. kraft grades)
Basis Weight	93 g/m^2 (57 lb/3000 sq ft)	Pulp Yield	93%
Production	120 MDMT/day; 39,600 MDMT/yr	Mill Location	Northeast
Net Operating Days	330/yr	Boundary Limits	S/F preparation through paper making

CAPITAL REQUIREMENTS* ($000)

Physical Plant	18,800	
Other Fixed Capital	1,900	
Total Fixed Capital		21,000
Working Capital		3,000
Total Capital Required		24,000

ENERGY REQUIREMENTS (per MDMT)

	Steam (kg)	Power (kWh)
Pulping, Cleaning & Stock Prep.	–	300
Paper Making	4,000	100
Water & Effluent Treatment	–	60
Misc. & Auxiliaries	600	170
Total	4,600	630

OPERATING COST* ($/MDMT)

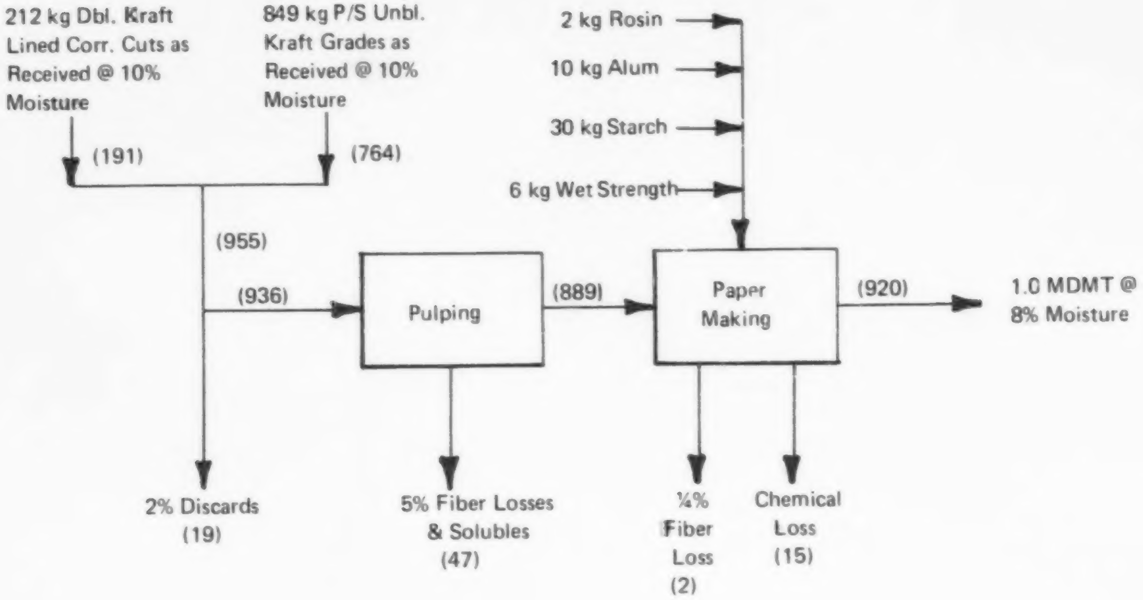
Fiber Furnish	99.8	
Other Raw Materials	11.5	
Total Raw Materials Cost		111.4
Labor + Fringe @ 32% of Hourly Rate	31.7	
Supplies	8.8	
Energy	32.2	
Factory Overhead	16.4	
Total Conversion Costs		89.1
Capital-Related Costs		40.9
• Total Factory Operating Cost		241.4 ($218.9/MDST)
GS&A	7.0	
Freight Out	15.0	
Total Cost of Sales		22.0
• Total Delivered Cost		263.4 ($238.9/MDST)

*Totals may not add due to rounding.

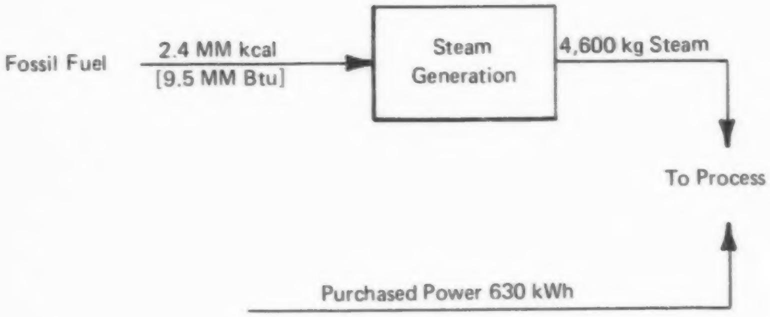
Figure IX-J-4

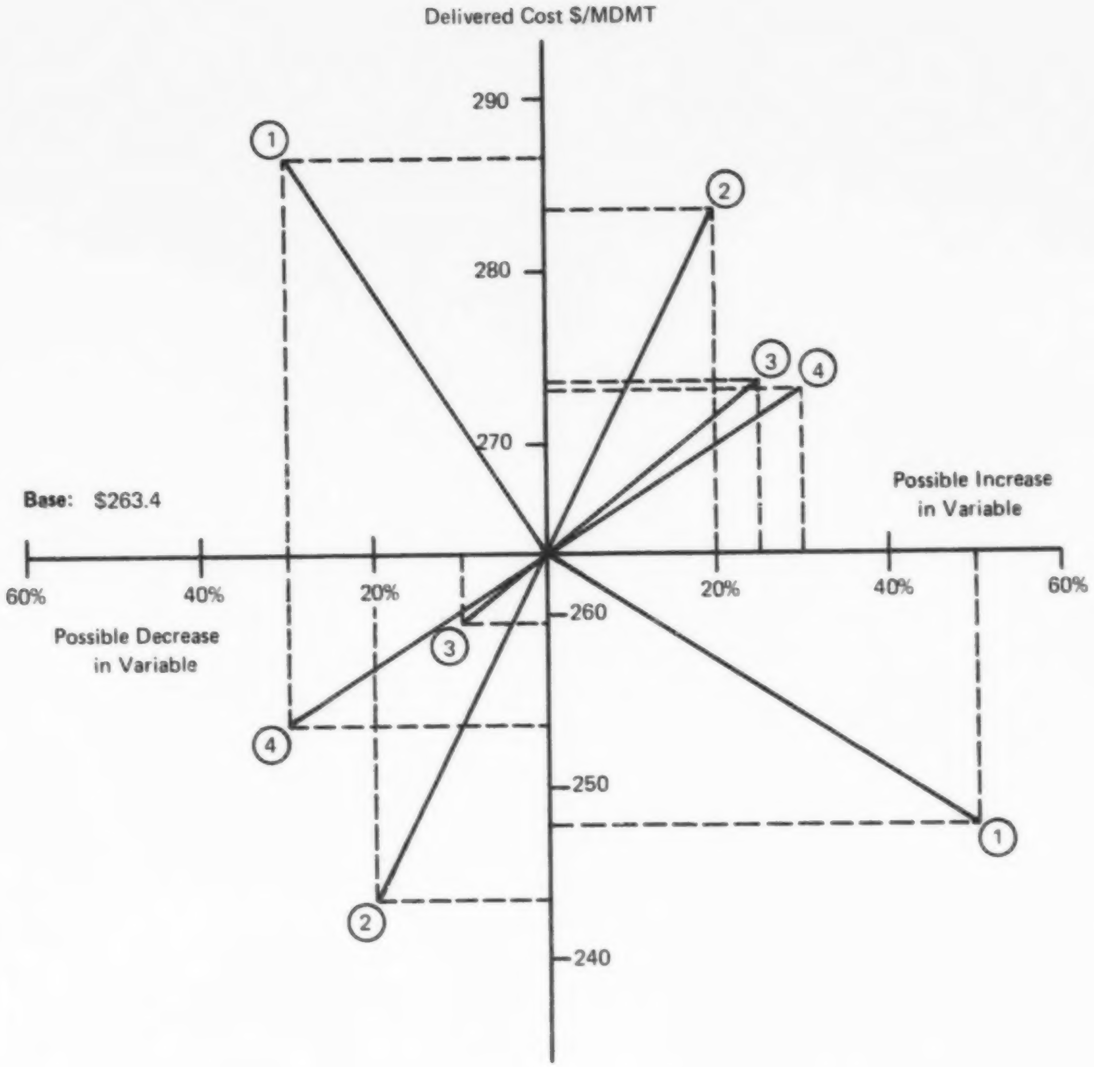
MATERIAL AND ENERGY BALANCE

(Basis: 1.0 MDMT bag paper)


212 kg Dbl. Kraft Lined Corr. Cuts as Received @ 10% Moisture
849 kg P/S Unbl. Kraft Grades as Received @ 10% Moisture
(191)
(764)
(955)
(936)
2 kg Rosin
10 kg Alum
30 kg Starch
6 kg Wet Strength
Pulping
(889)
Paper Making
(920)
1.0 MDMT @ 8% Moisture
2% Discards (19)
5% Fiber Losses & Solubles (47)
¼% Fiber Loss (2)
Chemical Loss (15)

( ) indicates BD kg


Fossil Fuel
2.4 MM kcal [9.5 MM Btu]
Steam Generation
4,600 kg Steam
To Process
Purchased Power 630 kWh



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+50, −30	120	180	84
2. Delivered Cost of Fiber,* $/ADMT	+20, −20	94	113	75
3. Fixed Capital, $ Million	+25, −10	21	26	19
4. Cost of Energy, $/MMBtu	+30, −30	2.0	2.6	1.4

*Average Cost of Secondary Fiber

FIGURE IX–J–5 SENSITIVITY OF THE MANUFACTURING COST OF UNBLEACHED KRAFT BAG PAPER (SECONDARY) TO KEY VARIABLES

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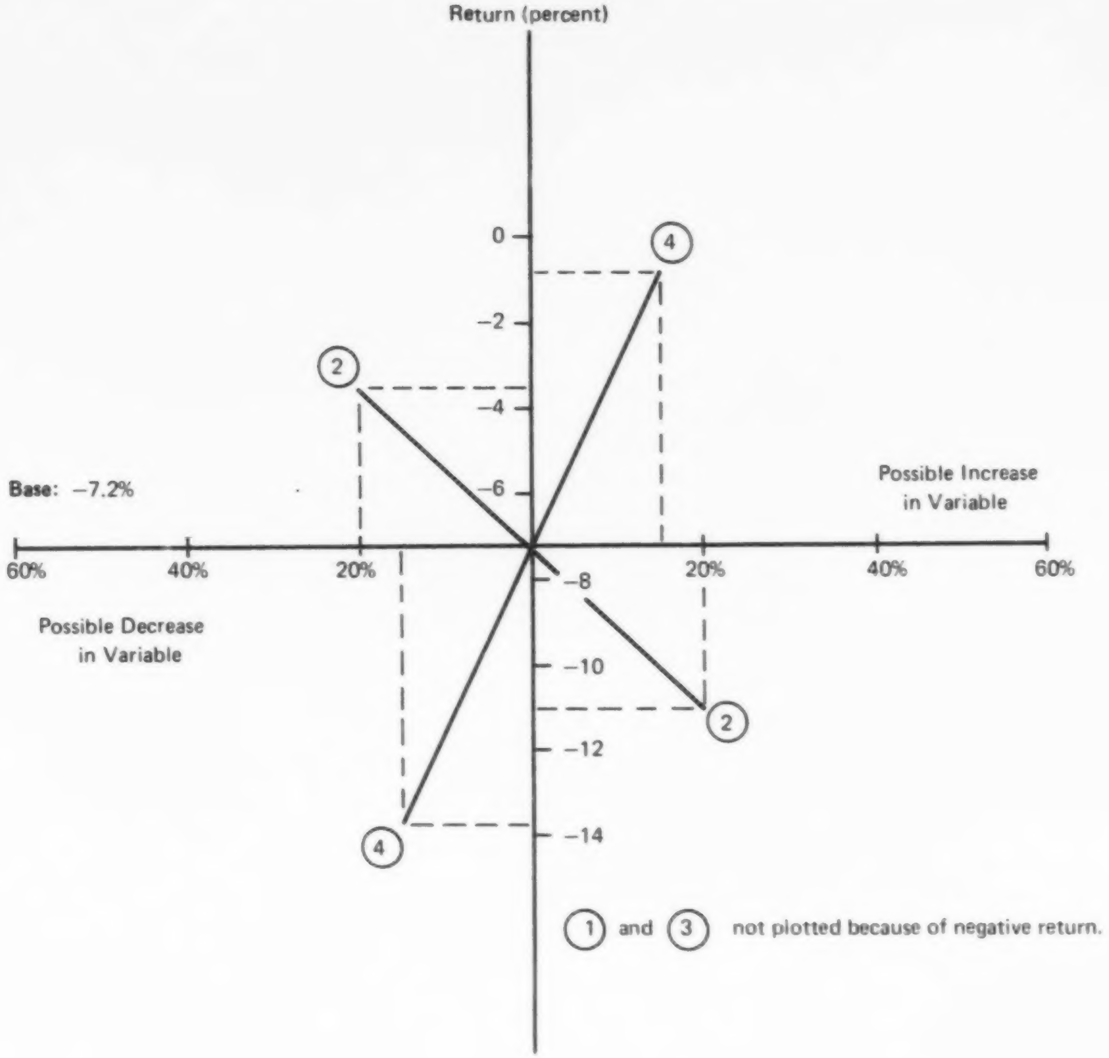


KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+50, –30	120	180	84
2. Delivered Cost of Fiber,* $/ADMT	+20, –20	94	113	75
3. Fixed Capital, $ Million	+25, –10	21	26	19
4. Selling Price, $/MDMT	+15, –15	225	259	191

*Average Cost of Secondary Fiber.

FIGURE IX–J–6 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF UNBLEACHED KRAFT BAG PAPER (SECONDARY) TO KEY VARIABLES

Table IX-J-6

DESIGN BASIS

Functional Group	Industrial Packaging, converting & Misc.	Process	Integrated to unbl. kraft pulp mill
Grade	Unbl. kraft bag paper	Fiber Furnish	70% unbl. SW kraft, 30% S/F (24% P/S unbl. kraft grades, 6% dbl. kraft lined corr. cuts)
Basis Weight	93 g/m^2 (57 lb/3000 sq ft)	Pulp Yield	93% for S/F
Production	210 MDMT/day; 69,300 MDMT/yr	Mill Location	Southeast
Net Operating Days	330/yr	Boundary Limits	Transfer of slush pulp and S/F production through paper making

CAPITAL REQUIREMENTS*
($000)

Physical Plant	26,000	
Other Fixed Capital	2,600	
Total Fixed Capital		29,000
Working Capital		3,000
Total Capital Required		32,000

ENERGY REQUIREMENTS
(per MDMT)

	Steam (kg)	Power (kWh)
Pulping & Stock Prep	–	240
Paper Making	4,000	100
Water & Effluent Treatment	–	60
Misc. & Auxiliaries	600	160
Total	4,600	560

OPERATING COST*
($/MDMT)

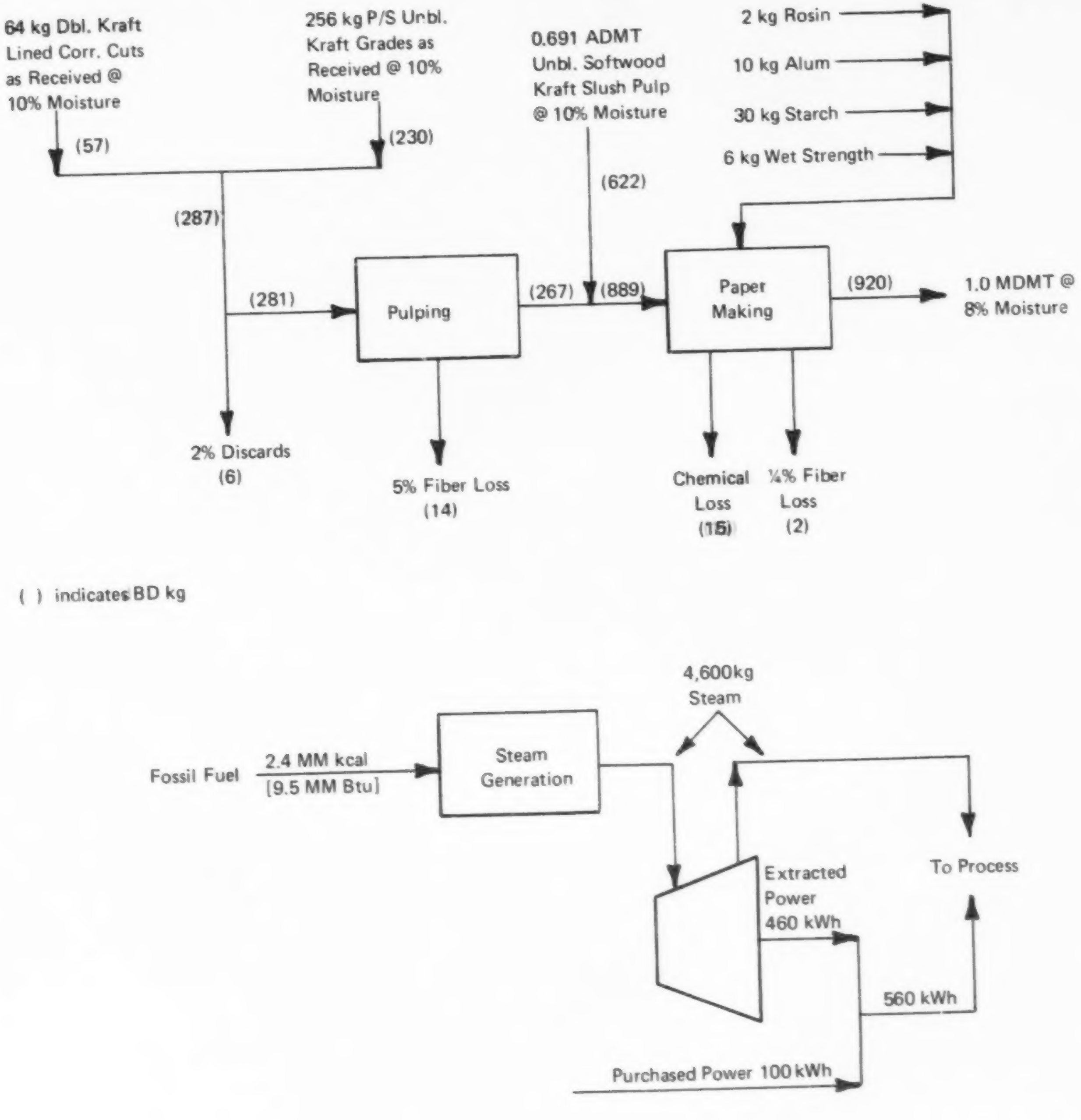
Fiber Furnish	92.7	
Other Raw Materials	11.0	
Total Raw Materials Cost		103.6
Labor + Fringe @ 32% of Hourly Rate	18.1	
Supplies	8.3	
Energy	10.7	
Factory Overhead	6.2	
Total Conversion Costs		43.1
Capital-Related Costs		32.0
• Total Factory Operating Cost		178.8 ($162.2/MDST)
GS&A	7.0	
Freight Out	18.0	
Total Cost of Sales		25.0
• Total Delivered Cost		203.8 ($184.8/MDST)

*Totals may not add due to rounding.

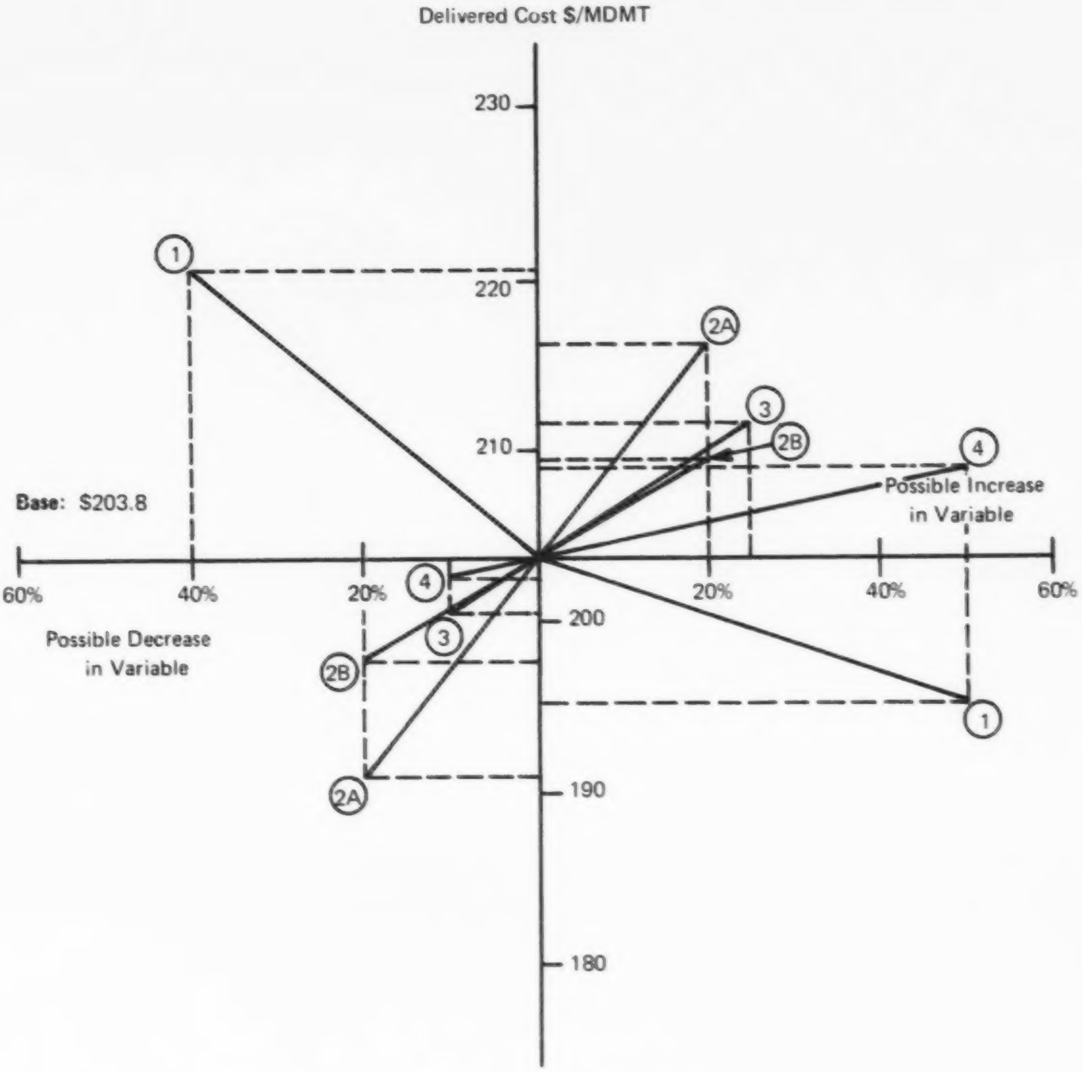
Figure IX-J-7

MATERIAL AND ENERGY BALANCE

(**Basis:** 1.0 MDMT bag paper)


64 kg Dbl. Kraft Lined Corr. Cuts as Received @ 10% Moisture
(57)
256 kg P/S Unbl. Kraft Grades as Received @ 10% Moisture
(230)
(287)
(281)
Pulping
(267)
0.691 ADMT Unbl. Softwood Kraft Slush Pulp @ 10% Moisture
(622)
(889)
2 kg Rosin
10 kg Alum
30 kg Starch
6 kg Wet Strength
Paper Making
(920)
1.0 MDMT @ 8% Moisture
2% Discards (6)
5% Fiber Loss (14)
Chemical Loss (15)
¼% Fiber Loss (2)
Fossil Fuel
2.4 MM kcal
[9.5 MM Btu]
Steam Generation
4,600kg Steam
Extracted Power 460 kWh
To Process
560 kWh
Purchased Power 100 kWh

( ) indicates BD kg



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+50, −40	210	315	125
2. A B Delivered Cost of Fiber,* $/ADMT	+20, −20	91 94	110 113	73 75
3. Fixed Capital, $ Million	+25, −10	29	36	26
4. Cost of Energy, $/MMBtu	+50, −10	1.0	1.5	0.9

*2A—Slush Pulp Cost, 2B—Average Secondary Fiber Cost

FIGURE IX–J–8 SENSITIVITY OF THE MANUFACTURING COST OF UNBLEACHED KRAFT BAG PAPER (BLENDED) TO KEY VARIABLES

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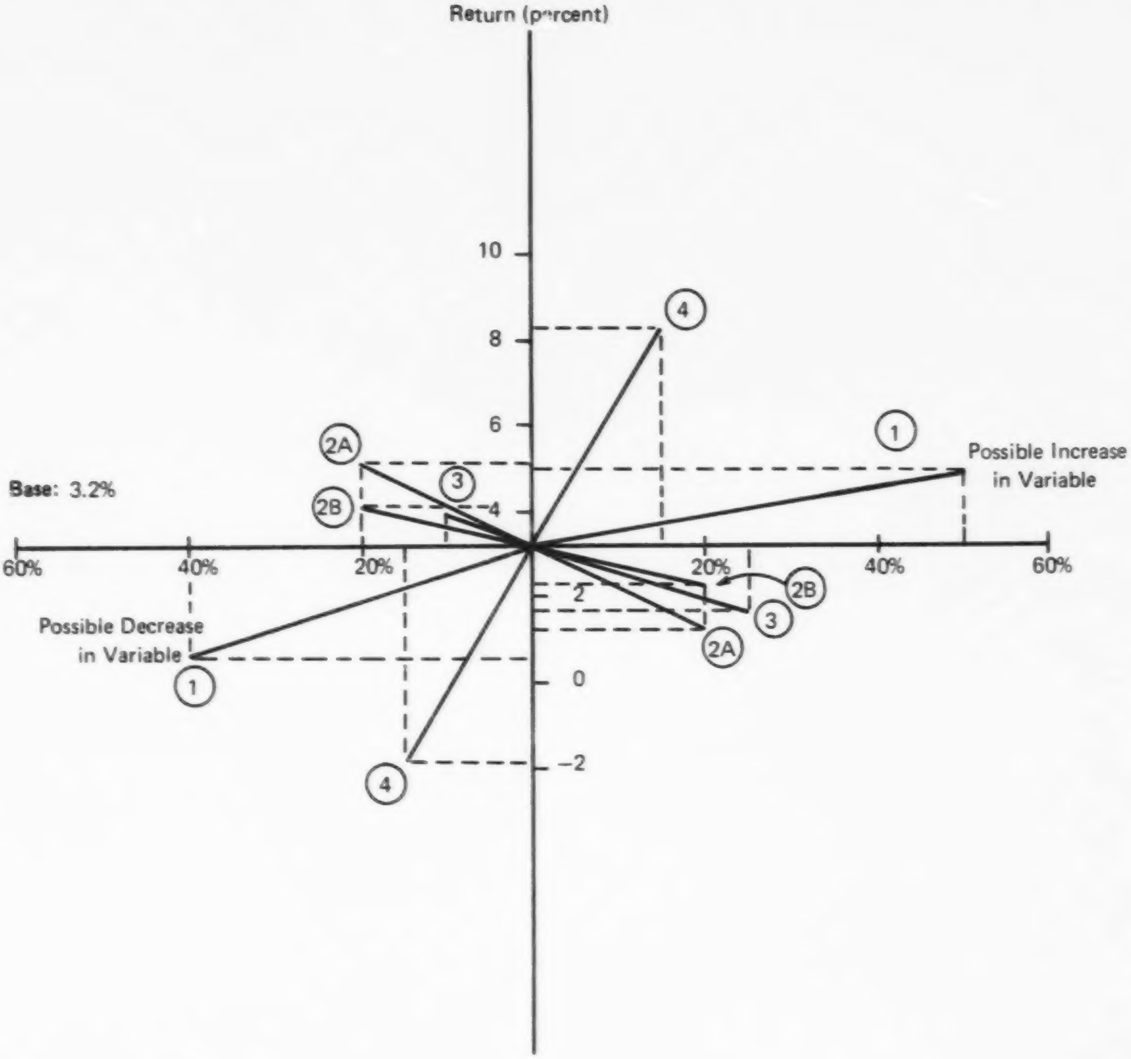

KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+50, −40	210	315	125
2. A Delivered Cost of Fiber,* $/ADMT	+20, −20	91	110	73
B		94	113	75
3. Fixed Capital,** $ Million	+25, −10	29	36	26
4. Selling Price, $/MDMT	+15, −15	225	259	191

*2A—Slush Pulp Cost, 2B—Average Secondary Fiber Cost

**Variation applies to papermaking operation only; allocated fixed capital for pulp manufacture is assumed constant at $17 million.

FIGURE IX–J–9 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF UNBLEACHED KRAFT BAG PAPER (BLENDED) TO KEY VARIABLES

TABLE IX-J-8

ECONOMIC COMPARISON OF UNBLEACHED KRAFT BAG PAPER MANUFACTURE FROM VIRGIN VS. SECONDARY FIBER (NONINTEGRATED MILL)

Functional Group	Industrial, Packaging, Converting, & Misc.	
Grade	Unbleached Kraft Bag Paper	
Basis Weight (g/m^2)	93 (57 lb/3000 sq ft)	
Fiber Furnish	100% Virgin	100% Secondary
Plant Size (MT/day)	120	120
Plant Location	Northeast	Northeast
Plant Specifics	Nonintegrated	Nonintegrated
Total Fixed Capital ($Million)	19	21
Total delivered Cost ($/MDMT)	461.5	263.4
Raw Materials ($/MT delivered)	317.3	111.4
Conversion ($/MT)	85.6	89.1
Capital-Related ($/MT)	36.6	40.9
Sales Cost (less freight)($/MT)	7.0	7.0
Freight In ($/MT)*	21.8	10.6
Freight Out ($/MT)	15.0	15.0
Selling Price ($/MT)	225	225
Return on Fixed Capital, pre-tax(%)	-49.0	- 7.2

*Not included in total delivered cost

TABLE IX-J-9

DESIGN BASIS

Functional Group	Packaging Papers	Process	Market pulp
Grade	Unbleached kraft bag	Fiber Furnish	100% virgin (market pulp)
Basis Weight	93 g/m^2 (57 lb/3000 sq ft)	Pulp Yield	n.a.
Production	120 MDMT/day; 39,600/yr	Mill Location	Northeast
Net Operating Days	330/yr	Boundary Limits	Nonintegrated; purchased market pulp through papermaking

CAPITAL REQUIREMENTS*
($000)

Physical Plant	16,900	
Other Fixed Capital	1,700	
Total Fixed Capital		19,000
Working Capital		5,000
Total Capital Required		24,000

ENERGY REQUIREMENTS
(per MDMT)

Steam (kg)	Power (kWh)
4,100	630

OPERATING COST
($/MDMT)

Fiber Furnish	306.3	
Other Raw Materials	11.0	
Total Raw Materials Cost		317.3
Labor + Fringe @ 32% of Hourly Rate	29.5	
Supplies	8.4	
Energy	32.2	
Factory Overhead	15.5	
Total Conversion Costs		85.6
Capital-Related Costs		36.6
● Total Factory Operating Cost		439.5 ($398.6/MDST)
GS&A	7.0	
Freight Out	15.0	
Total Cost of Sales		22.0
● Total Delivered Cost		461.5 ($418.6/MDST)

*Totals may not add due to rounding.

TABLE IX-J-11

ECONOMIC COMPARISON OF UNBLEACHED KRAFT TUBE PAPER MANUFACTURE

Functional Group	Industrial packaging, converting & Misc.		
Grade	Unbleached Kraft Tube Paper		
Basis Weight (g/m^2)	146 (90 lb/3000 sq ft)		
Fiber Furnish	100% Virgin	100% S/F	30% Virgin 70% S/F
Plant Size (MT/Day)	240	136	240
Plant Location	Southeast	Northeast	Southeast
Plant Specifics	Integrated	Nonintegrated	Integrated
Total Fixed Capital* ($Million)	55	21	37
($000/Daily Ton)	229	154	154
Total Delivered Cost ($/MDMT)	189.8	250.6	199.6
Raw Materials ($/MT, delivered)	101.1	111.3	107.8
Conversion ($/MT)	39.6	84.2	41.7
Capital-Related ($/MT)	27.0	36.0	28.2
Sales Cost (less freight) ($/MT)	7.0	7.0	7.0
Freight in ($/MT Product) **	14.3	10.6	11.7
Freight out ($/MT Product)	15.0	12.0	15.0
Selling Price ($/MDMT)	210	210	210
Return on Fixed Capital*, pre-tax (%)	2.9	- 8.7%	2.2%

* Including pulping

** Not included in total delivered cost

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Table IX-J-12

DESIGN BASIS

Functional Group	Industrial Packaging, converting and Misc.	Process	Integrated to unbl. kraft pulp mill
Grade	Tube Paper	Fiber Furnish	100% unbl. SW kraft slush pulp
Basis Weight	146 g/m^2 (90 lb/3000 sq ft)	Pulp Yield	n.a.
Production	240 MDMT/day; 79,200 MDMT/yr	Mill Location	Southeast
Net Operating Days	330/yr	Boundary Limits	Transfer of slush pulp through paper making

CAPITAL REQUIREMENTS* ($000)

Physical Plant	25,000	
Other Fixed Capital	2,500	
Total Fixed Capital		28,000
Working Capital		4,000
Total Capital Required		32,000

ENERGY REQUIREMENTS (per MDMT)

	Steam (kg)	Power (kWh)
Stock Preparation	–	230
Paper Making	4,000	105
Water & Effluent Treatment	–	50
Misc. & Auxiliaries	600	180
Total	4,600	565

OPERATING COST* ($/MDMT)

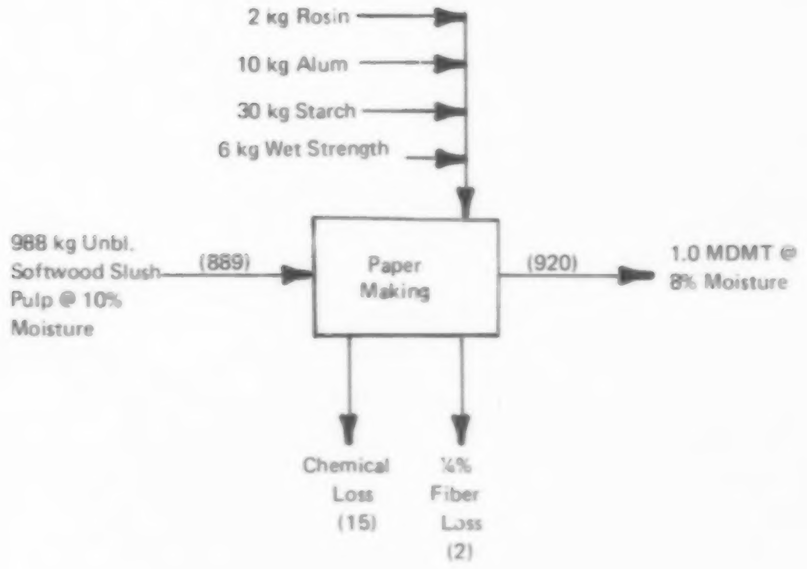
Fiber Furnish	90.2	
Other Raw Materials	11.0	
Total Raw Materials Cost		101.1
Labor + Fringe @ 32% of Hourly Rate	15.4	
Supplies	8.3	
Energy	10.8	
Factory Overhead	5.2	
Total Conversion Costs		39.6
Capital-Related Costs		27.0
• Total Factory Operating Cost		167.8 ($152.2/MDST)
GS&A	7.0	
Freight Out	15.0	
Total Cost of Sales		22.0
• Total Delivered Cost		189.8 ($209.2/MDST)

*Totals may not add due to rounding.

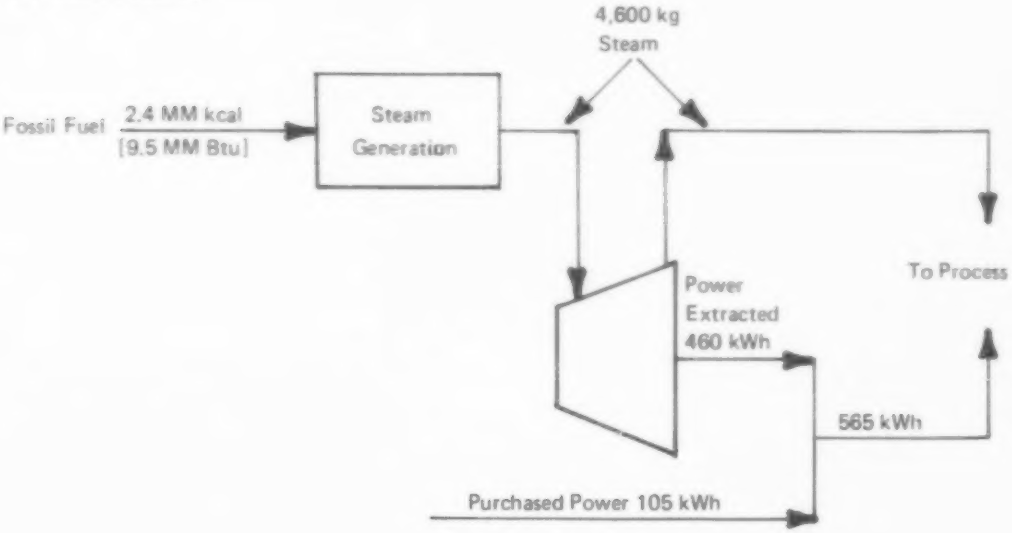
Figure IX-J-10

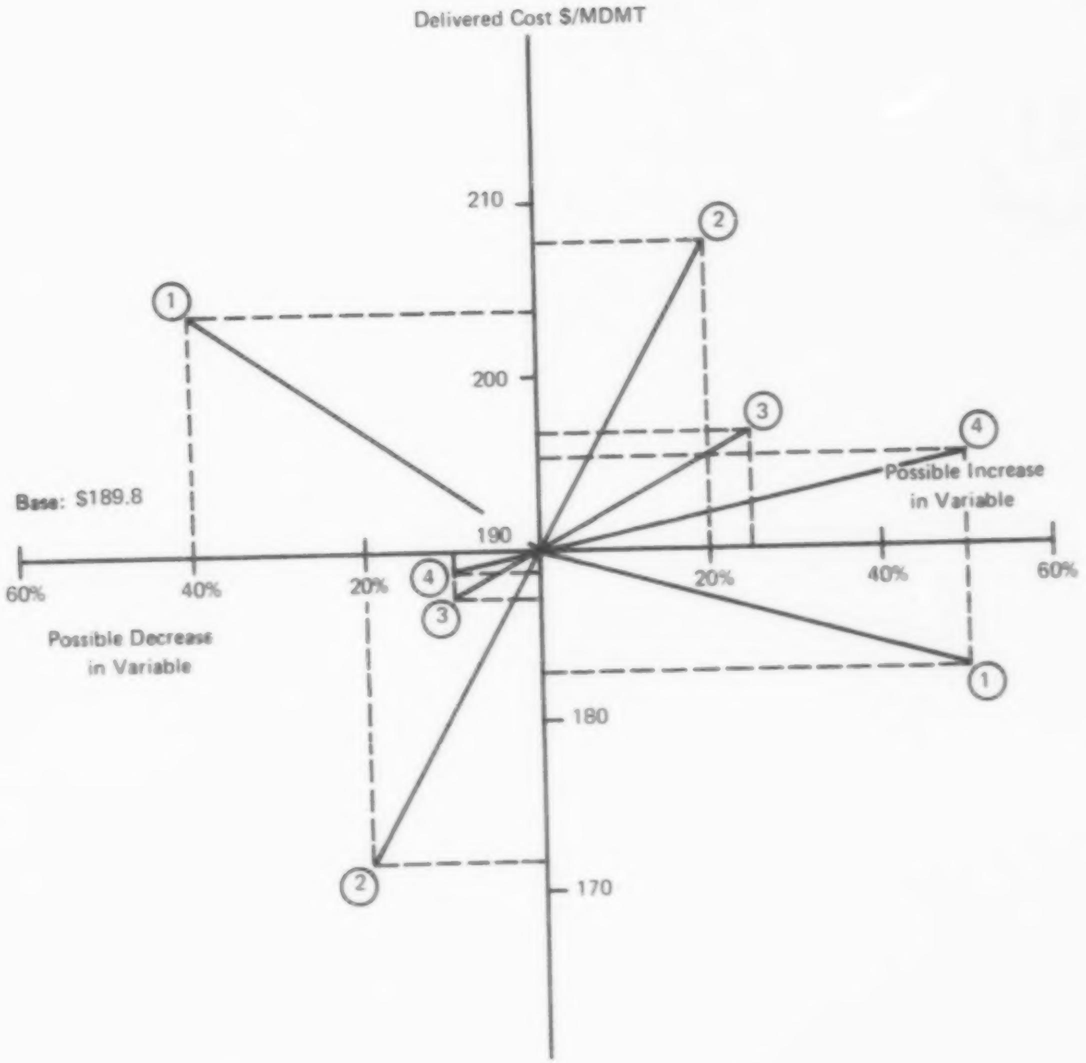
MATERIAL AND ENERGY BALANCE

(Basis: 1.0 MDMT tube paper)


2 kg Rosin
10 kg Alum
30 kg Starch
6 kg Wet Strength
988 kg Unbl. Softwood Slush Pulp @ 10% Moisture
(889)
Paper Making
(920)
1.0 MDMT @ 8% Moisture
Chemical Loss (15)
¼% Fiber Loss (2)

( ) indicates BD kg


4,600 kg Steam
Fossil Fuel
2.4 MM kcal
[9.5 MM Btu]
Steam Generation
To Process
Power Extracted 460 kWh
565 kWh
Purchased Power 105 kWh



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+50, –40	240	360	144
2. Delivered Cost of Fiber,* $/ADMT	+20, –20	91	110	73
3. Fixed Capital, $ Million	+25, –10	28	35	25
4. Cost of Energy, $/MMBtu	+50, –10	1.0	1.5	0.9

*Slush Pulp Cost

FIGURE IX–J–11 SENSITIVITY OF THE MANUFACTURING COST OF TUBE PAPER (VIRGIN) TO KEY VARIABLES

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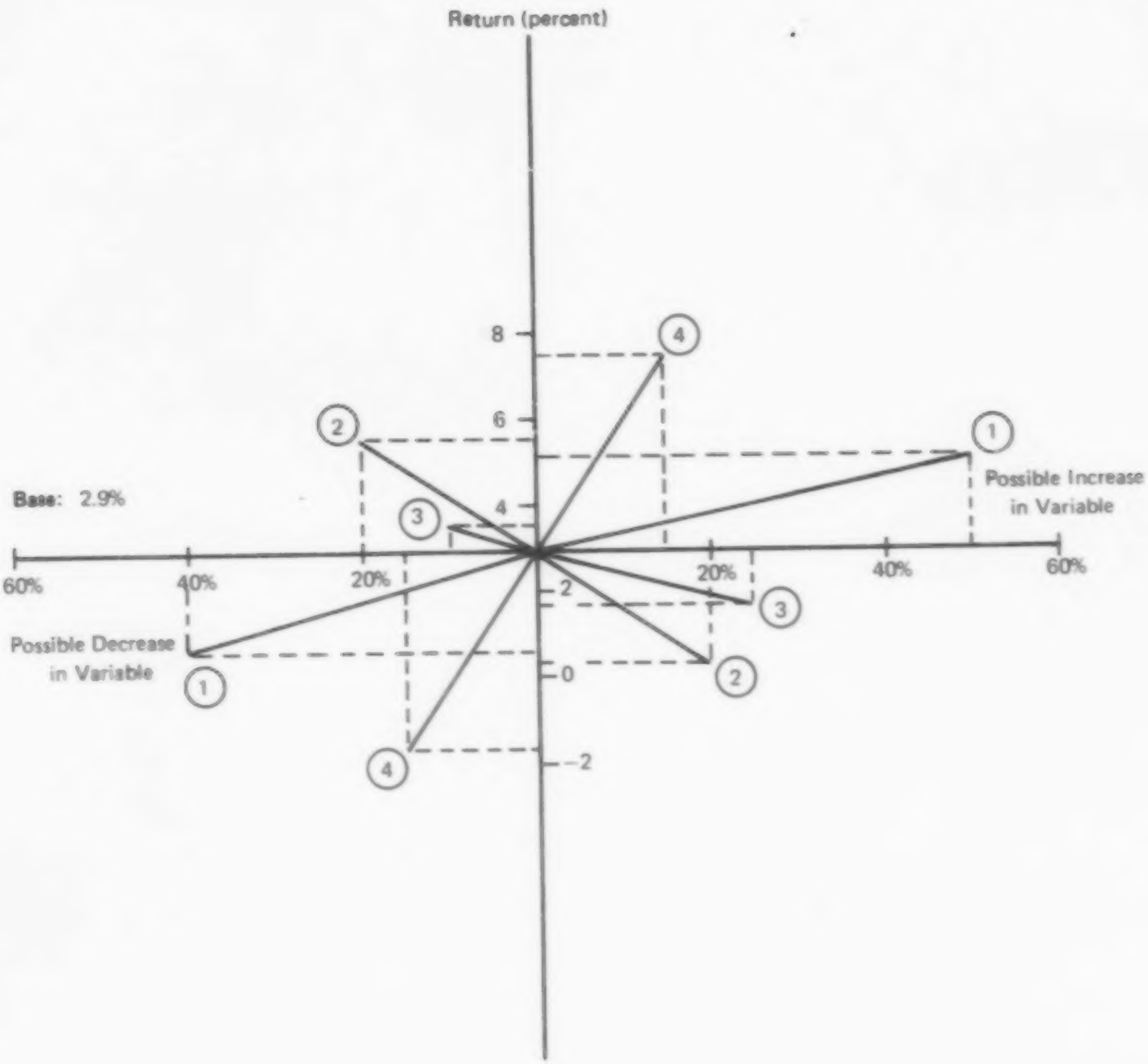


KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+50, −40	240	360	144
2. Delivered Cost of Fiber,* $/ADMT	+20, −20	91	110	73
3. Fixed Capital,** $ Million	+25, −10	28	35	25
4. Selling Price, $/MDMT	+14, −15	210	242	178

*Slush Pulp Cost

**Variation applies to papermaking operation only; allocated fixed capital for pulp manufacture is assumed constant at $27 million.

FIGURE IX–J–12 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF TUBE PAPER (VIRGIN) TO KEY VARIABLES

Table IX-J-14

DESIGN BASIS

Functional Group	Industrial Packaging, Converting & Misc.	Process	S/F pulping
Grade	Tube paper	Fiber Furnish	100% S/F (20% dbl. kraft lined corr. cuts, 80% P/S unbl. kraft grades)
Basis Weight	146 g/m^2 (90 lb/3000 sq ft)	Pulp Yield	93%
Production	136 MDMT/day; 45,000 MDMT/yr	Mill Location	Northeast
Net Operating Days	330/yr	Boundary Limits	S/F preparation through paper making

CAPITAL REQUIREMENTS* (\$000)

Physical Plant	18,800	
Other Fixed Capital	1,900	
Total Fixed Capital		21,000
Working Capital		3,000
Total Capital Required		24,000

ENERGY REQUIREMENTS (per MDMT)

	Steam (kg)	Power (kWh)
Pulping	–	315
Paper Making	4,000	105
Water & Effluent Treatment	–	60
Misc. & Auxiliaries	600	180
Total	4,600	660

OPERATING COST* (\$/MDMT)

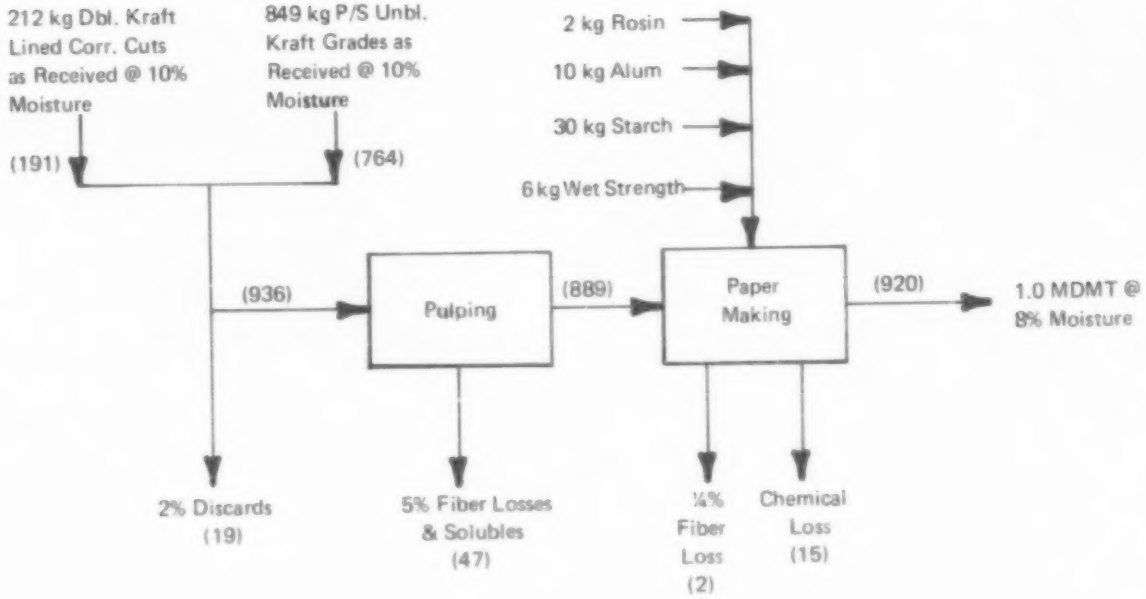
Fiber Furnish	99.8	
Other Raw Materials	11.5	
Total Raw Materials Cost		111.3
Labor + Fringe @ 32% of Hourly Rate	28.1	
Supplies	8.8	
Energy	32.9	
Factory Overhead	14.4	
Total Conversion Costs		84.2
Capital-Related Costs		36.0
● Total Factory Operating Cost		231.6 (\$210.1/MDST)
GS&A	7.0	
Freight Out	12.0	
Total Cost of Sales		19.0
● Total Delivered Cost		250.6 (\$276.2/MDST)

*Totals may not add due to rounding.

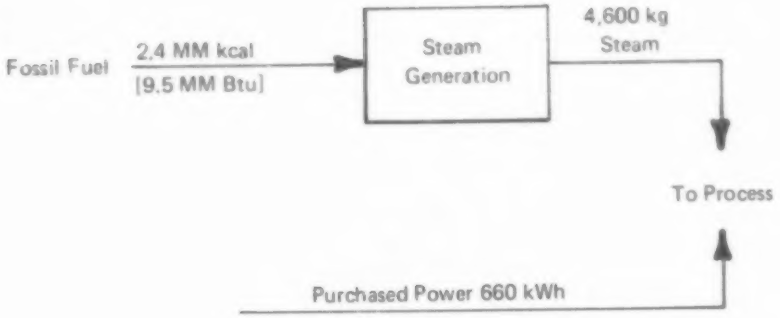
Figure IX-J-13

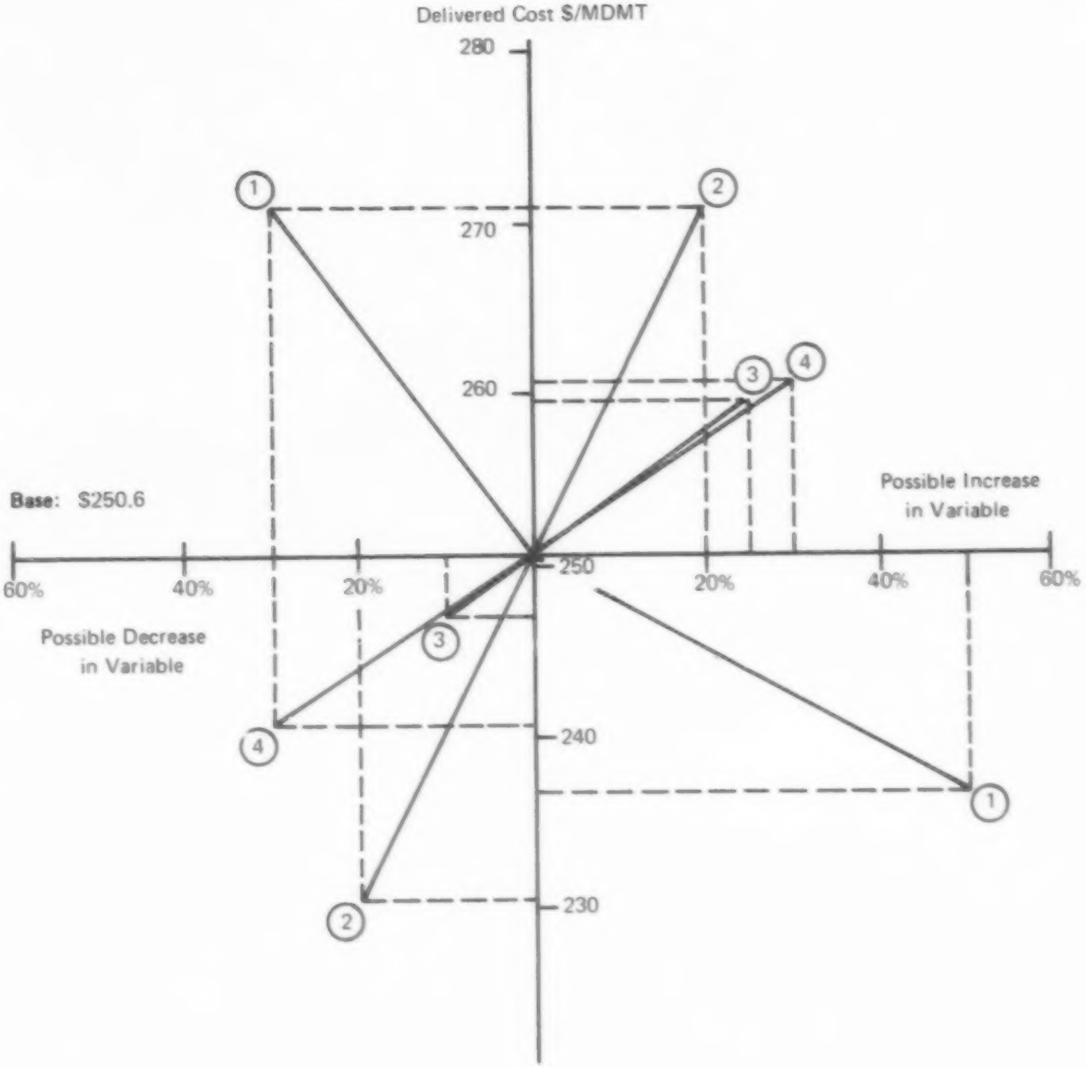
MATERIAL AND ENERGY BALANCE

(Basis: 1.0 MDMT tube paper)


212 kg Dbl. Kraft Lined Corr. Cuts as Received @ 10% Moisture
849 kg P/S Unbl. Kraft Grades as Received @ 10% Moisture
(191)
(764)
2 kg Rosin
10 kg Alum
30 kg Starch
6 kg Wet Strength
(936)
Pulping
(889)
Paper Making
(920)
1.0 MDMT @ 8% Moisture
2% Discards (19)
5% Fiber Losses & Solubles (47)
¼% Fiber Loss (2)
Chemical Loss (15)

( ) indicates BD kg


Fossil Fuel
2.4 MM kcal
[9.5 MM Btu]
Steam Generation
4,600 kg Steam
To Process
Purchased Power 660 kWh



KEY VARIABLES		Percent Variation	Best Guess	Possible High	Possible Low
1.	Scale of Operations, MTPD	+50, −30	136	204	95
2.	Delivered Cost of Fiber,* $/ADMT	+20, −20	94	113	75
3.	Fixed Capital, $ Million	+25, −10	21	26	19
4.	Cost of Energy, $/MMBtu	+30, −30	2.0	2.6	1.4

*Average Secondary Fiber Cost

FIGURE IX–J–14 SENSITIVITY OF THE MANUFACTURING COST OF TUBE PAPER (SECONDARY) TO KEY VARIABLES

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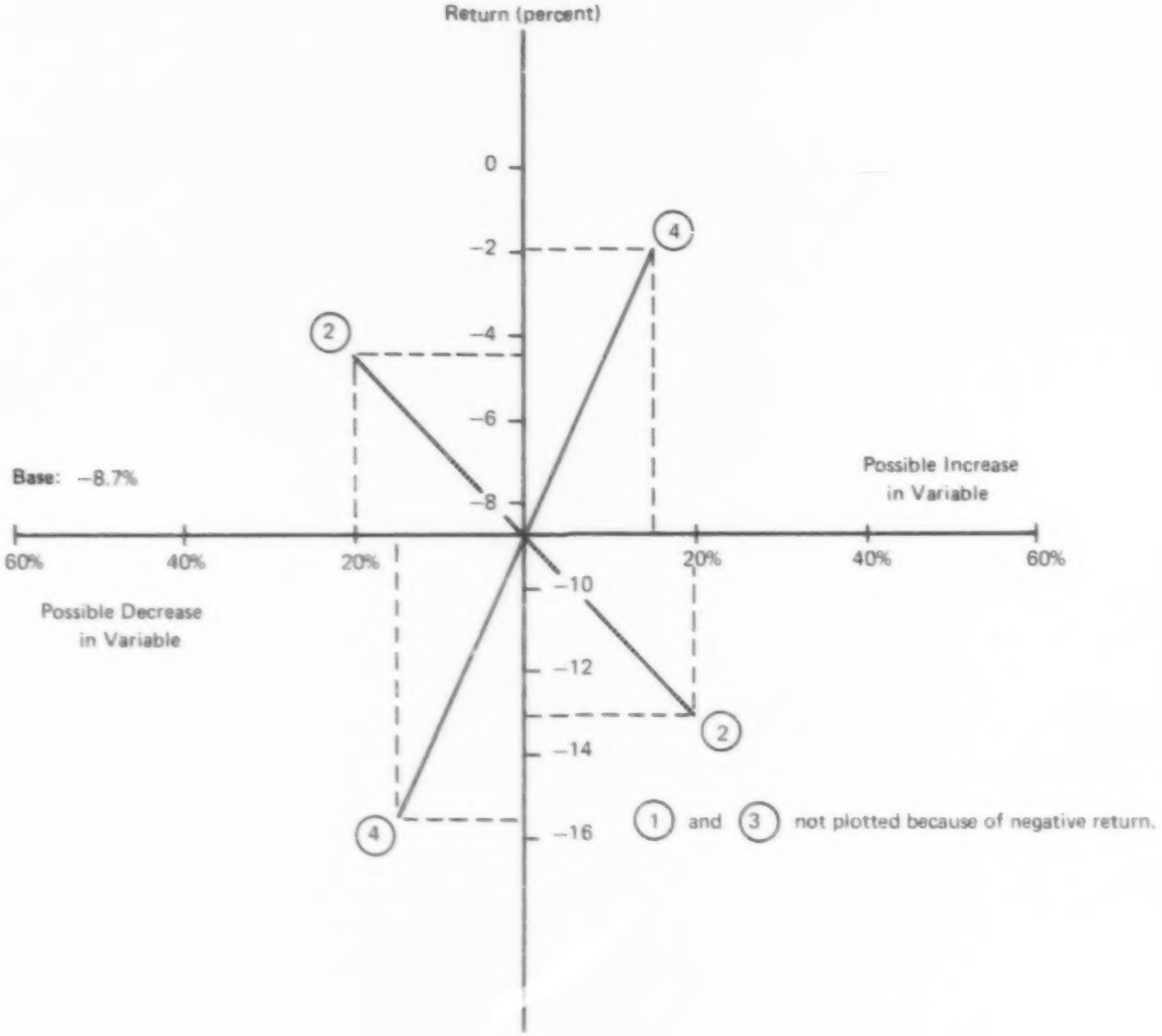


KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+50, −30	136	204	95
2. Delivered Cost of Fiber,* $/ADMT	+20, −20	94	113	75
3. Fixed Capital, $ Million	+25, −10	21	26	19
4. Selling Price, $/MDMT	+15, −15	210	242	178

*Average Secondary Fiber Cost

FIGURE IX–J–15 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF TUBE PAPER (SECONDARY) TO KEY VARIABLES

Table IX-J-16

DESIGN BASIS

Functional Group	Industrial Packaging, Converting & Misc.	Process	Integrated to unbl. kraft pulp mill
Grade	Tube paper	Fiber Furnish	30% unbl. SW kraft, 70% S/F (14% dbl. kraft lined corr. cuts, 56% P/S unbl. kraft grades)
Basis Weight	146 g/m^2 (90 lb/3000 sq ft)	Pulp Yield	93% for S/F
Production	240 MDMT/day; 79,200 MDMT/yr	Mill Location	Southeast
Net Operating Days	330/yr	Boundary Limits	Transfer of slush pulp and S/F preparation through paper making

CAPITAL REQUIREMENTS*
($000)

Physical Plant	26,500	
Other Fixed Capital	2,700	
Total Fixed Capital		29,000
Working Capital		4,000
Total Capital Required		33,000

ENERGY REQUIREMENTS
(per MDMT)

	Steam (kg)	Power (kWh)
Pulping	–	200
Stock Preparation	–	90
Paper Making	4,000	105
Water & Effluent Treatment	–	60
Misc. & Auxiliaries	600	180
Total	4,600	635

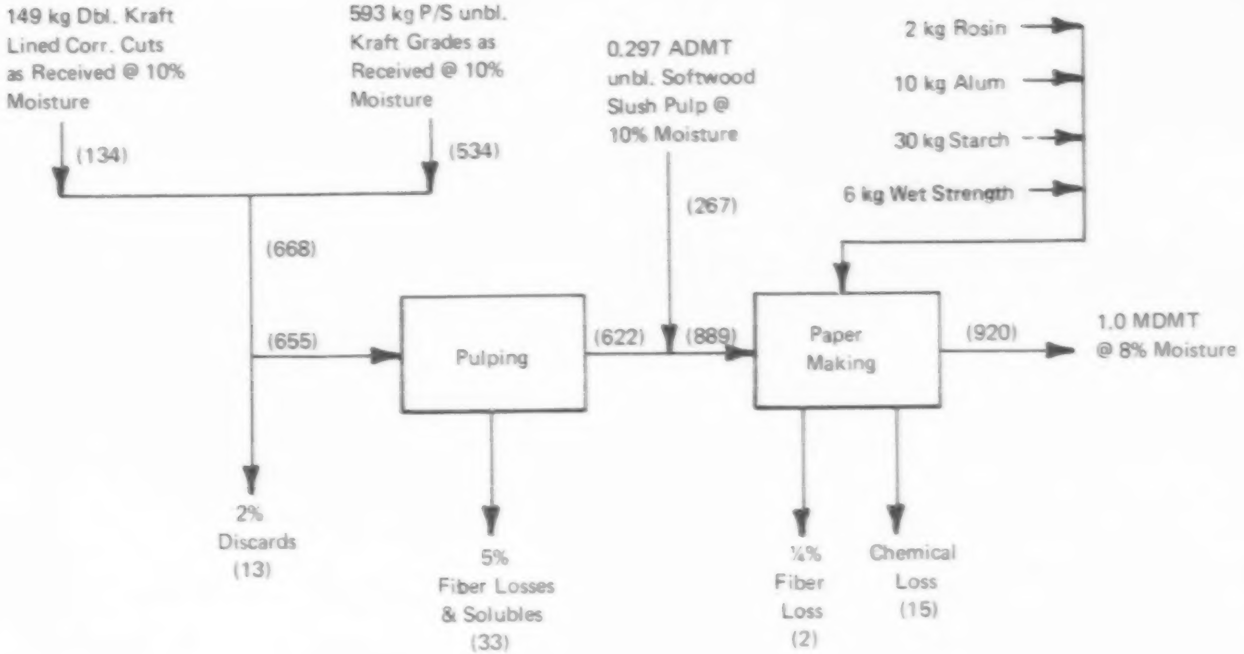
OPERATING COST*
($/MDMT)

Fiber Furnish	96.8	
Other Raw Materials	11.0	
Total Raw Materials Cost		107.8
Labor + Fringe @ 32% of Hourly Rate	16.2	
Supplies	8.3	
Energy	11.6	
Factory Overhead	5.6	
Total Conversion Costs		41.7
Capital-Related Costs		28.2
● Total Factory Operating Cost		177.7 ($195.8/MDST)
GS&A	7.0	
Freight Out	15.0	
Total Cost of Sales		22.0
● Total Delivered Cost		199.6 ($220.0/MDST)

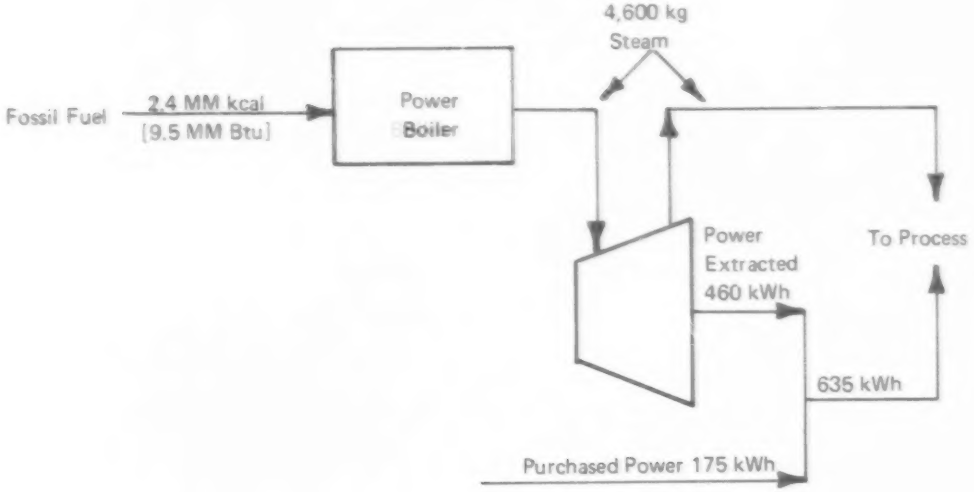
*Totals may not add due to rounding.

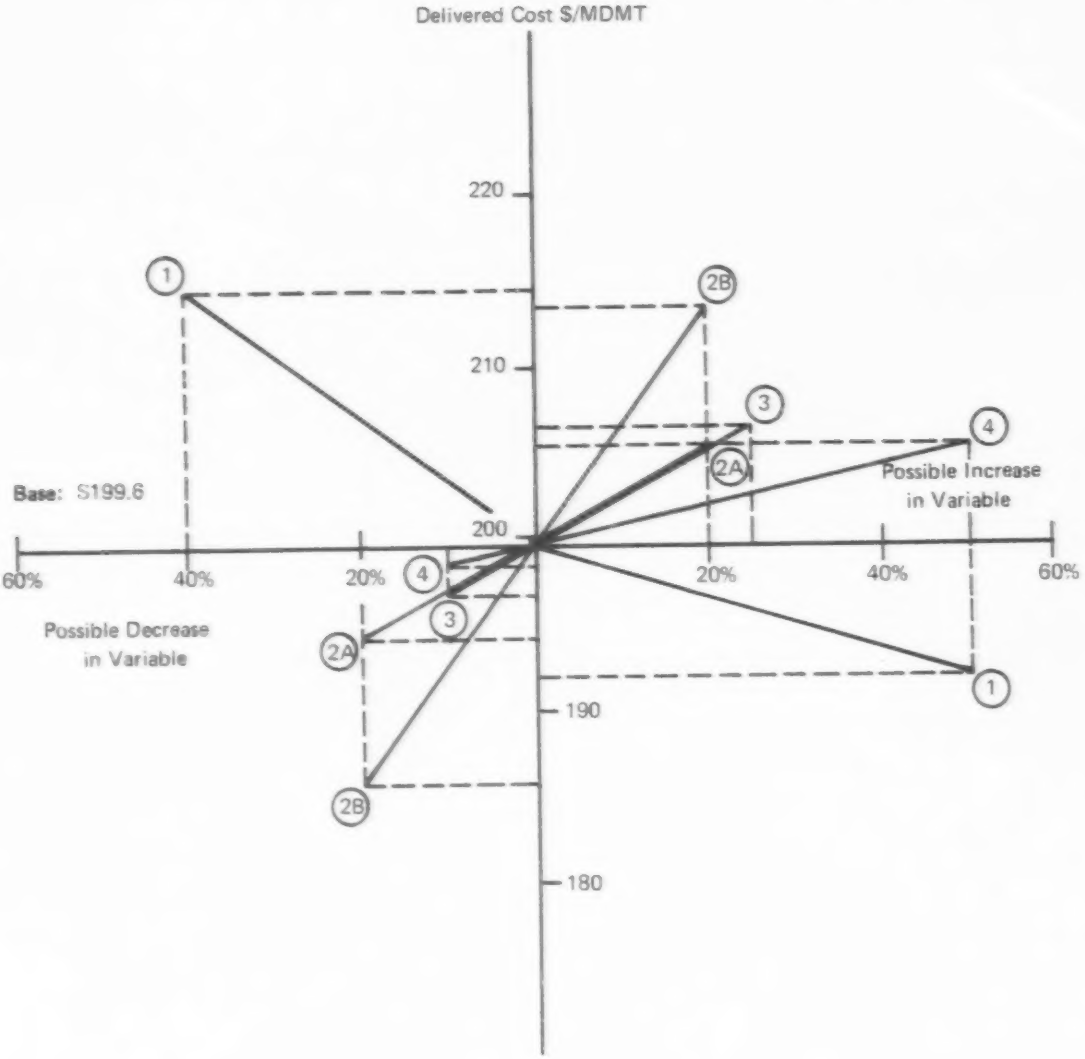
Figure IX-J-16

MATERIAL AND ENERGY BALANCE
(**Basis:** 1.0 MDMT tube paper)


149 kg Dbl. Kraft Lined Corr. Cuts as Received @ 10% Moisture
(134)
593 kg P/S unbl. Kraft Grades as Received @ 10% Moisture
(534)
0.297 ADMT unbl. Softwood Slush Pulp @ 10% Moisture
(267)
2 kg Rosin
10 kg Alum
30 kg Starch
6 kg Wet Strength
(668)
(655)
Pulping
(622)
(889)
Paper Making
(920)
1.0 MDMT @ 8% Moisture
2% Discards (13)
5% Fiber Losses & Solubles (33)
¼% Fiber Loss (2)
Chemical Loss (15)

( ) indicates BD kg


4,600 kg Steam
Fossil Fuel
2.4 MM kcal
[9.5 MM Btu]
Power Boiler
Power Extracted 460 kWh
To Process
635 kWh
Purchased Power 175 kWh



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+50, −40	240	360	144
2. A Delivered Cost of Fiber,* $/ADMT	+20, −20	91	110	73
B		94	113	75
3. Fixed Capital, $ Million	+25, −10	29	36	26
4. Cost of Energy, $/MMBtu	+50, −10	1.0	1.5	0.9

*2A–Slush Pulp Cost, 2B–Average Secondary Fiber Cost

FIGURE IX–J–17 SENSITIVITY OF THE MANUFACTURING COST OF TUBE PAPER (BLENDED) TO KEY VARIABLES

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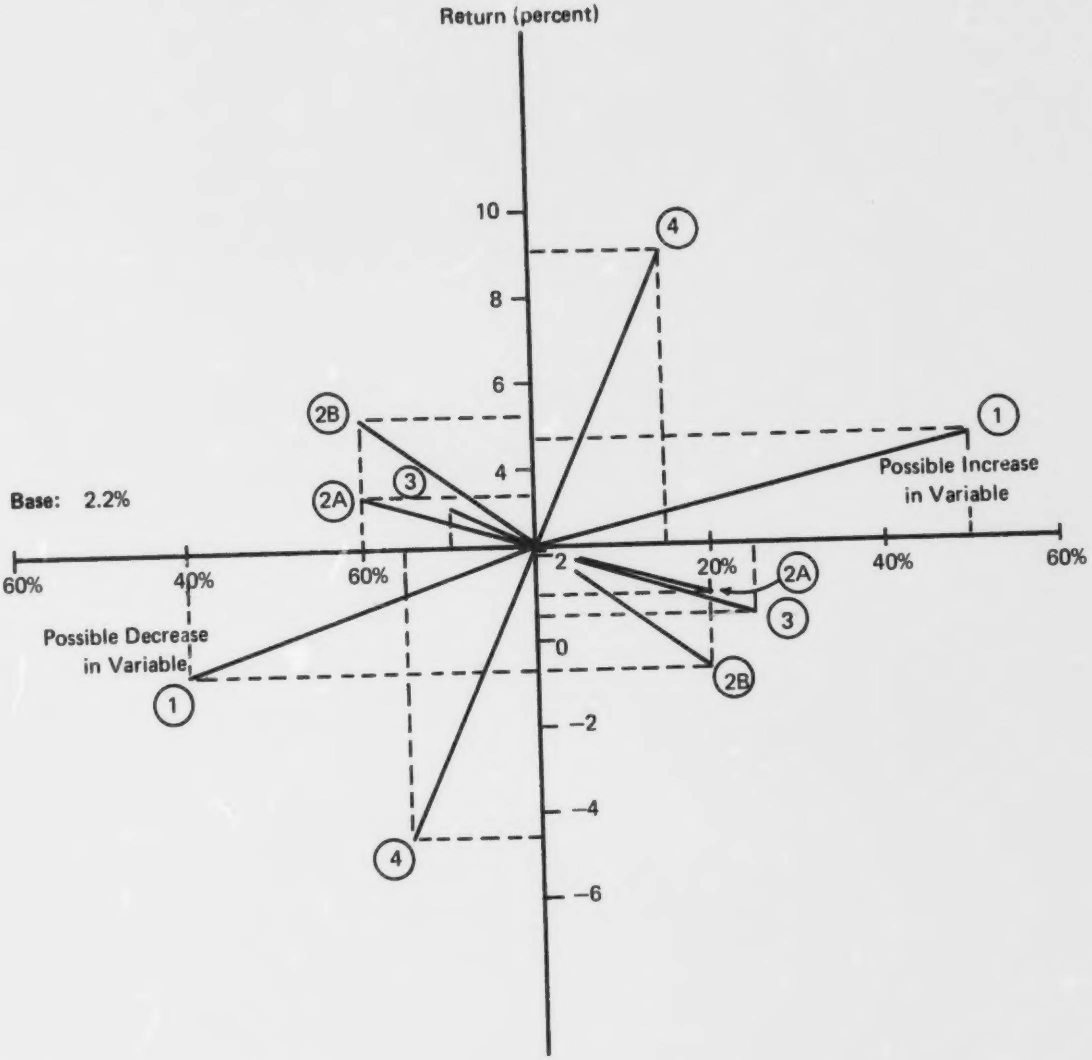


KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+50, −40	240	360	144
2. A Delivered Cost of Fiber,* $/ADMT	+20, −20	91	110	73
B		94	113	75
3. Fixed Capital,** $ Million	+25, −10	29	36	26
4. Selling Price, $/MDMT	+15, −15	210	242	178

*2A—Slush Pulp Cost, 2B—Average Secondary Fiber Cost

**Variation applies to papermaking operation only; allocated fixed capital for pulp manufacture is assumed constant at $8 million.

FIGURE IX-J-18 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF TUBE PAPER (BLENDED) TO KEY VARIABLES

K. CONSTRUCTION PAPERS

1. Roofing Felt

We have prepared a single model for roofing felt based on 45% virgin fiber and 55% secondary fiber. Roofing felt can be made in a range of grades using a variety of proportions and grades of secondary fiber, but there are no comparable 100% virgin or 100% secondary fiber products. After surveying industry data, we selected a plant capacity of 136 MDMT/day and a representative furnish of 45% refined softwood chips, 44% mixed waste paper, and 11% OCC.

Since no comparisons of costs or return on capital are applicable for this model, we have provided a sample cost calculation and a sensitivity chart for manufacturing cost to indicate the relative importance of secondary fiber cost in roofing felt production. Thus, changes in the conditions and assumptions we have made for this model can be tested readily. We have selected a North Central location as representative of roofing felt manufacture. Regional variations can be evaluated through use of the regional data previously presented (Table IX-C-1), in combination with the sensitivity chart.

Table IX-K-1

DESIGN BASIS

Functional Group	Const. Paper & Paperboard	Process	Integrated to converting operation
Grade	Roofing felt	Fiber Furnish	55% waste paper, 45% mechanical SW fiber
Basis Weight	510 g/m^3 (50 lb/480 sq ft)	Pulp Yield	99.5% mech. pulping, 94% S/F pulping
Production	136 MDMT/day; 45,000 MDMT/yr	Mill Location	North Central
Net Operating Days	330/yr	Boundary Limits	Wood and S/F preparation through felt making

CAPITAL REQUIREMENTS* ($000)

Physical Plant	11,500	
Other Fixed Capital	1 200	
Total Fixed Capital		13,000
Working Capital		1,000
Total Capital Required		14,000

ENERGY REQUIREMENTS (per MDMT)

	Steam (kg)	Power (kWh)
Pulping		
Mechanical	200	140
S/F	200	90
Stock Preparation	–	30
Paper Making	2,600	140
Effluent Treatment and Misc.	500	40
Total	3,500	440

OPERATING COST* ($/MDMT)

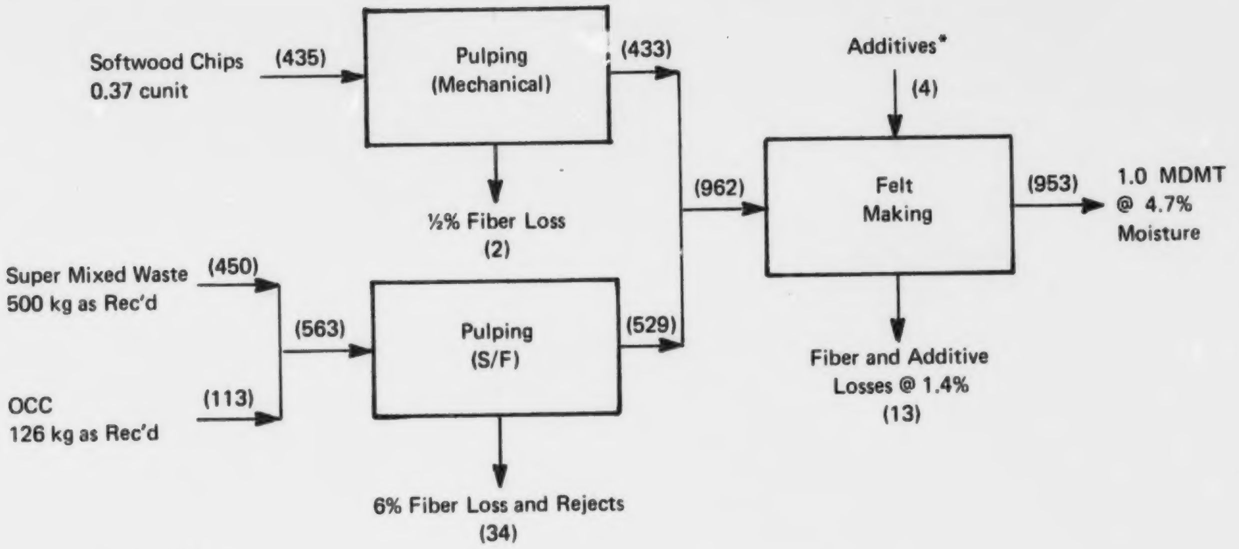
Fiber Furnish	33.7	
Other Raw Materials	1.8	
Total Raw Materials Cost		35.5
Labor + Fringe @ 32% of Hourly Rate	18.2	
Supplies	5.2	
Energy	21.9	
Factory Overhead	11.3	
Total Conversion Costs		56.7
Capital-Related Costs		22.0
• Total Factory Operating Cost		114.2 ($103.6/MDST)
GS&A	2.5	
Freight Out	n.a.	
Total Cost of Sales		2.5
• Total Delivered Cost		116.7 ($105.9/MDST)

*Totals may not add due to rounding.

Figure IX-K-1

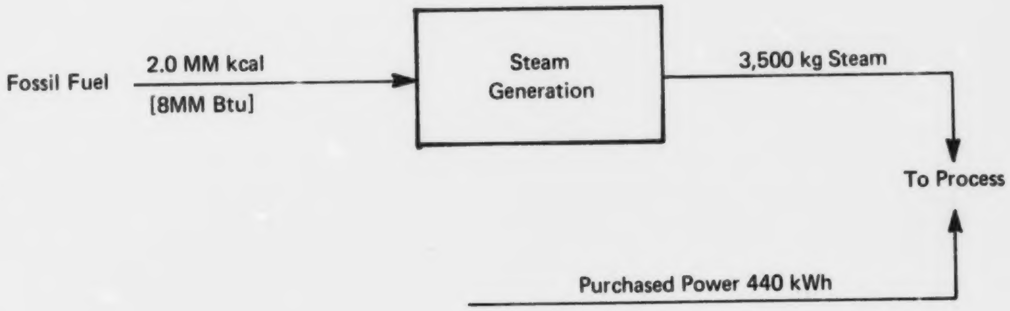
MATERIAL AND ENERGY BALANCE

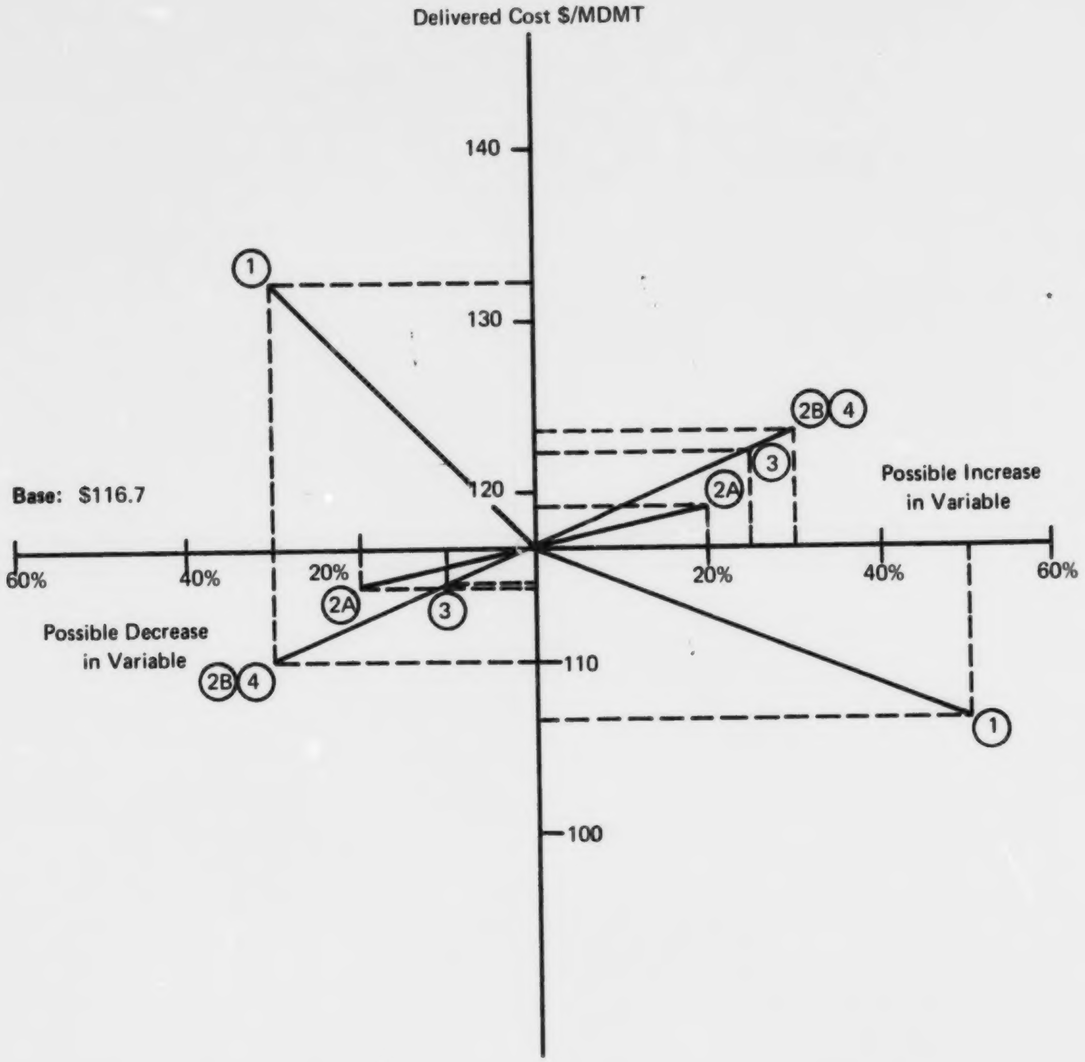
(Basis: 1.0 MDMT felt)


Softwood Chips
0.37 cunit
(435)
Pulping
(Mechanical)
(433)
½% Fiber Loss
(2)
Super Mixed Waste
500 kg as Rec'd
(450)
OCC
126 kg as Rec'd
(113)
(563)
Pulping
(S/F)
(529)
6% Fiber Loss and Rejects
(34)
(962)
Additives*
(4)
Felt
Making
(953)
1.0 MDMT
@ 4.7%
Moisture
Fiber and Additive
Losses @ 1.4%
(13)

( ) indicates BD kg

*Alum 2 kg, slimicides/detergents/defoaming agent 2 kg


Fossil Fuel
2.0 MM kcal
[8MM Btu]
Steam
Generation
3,500 kg Steam
To Process
Purchased Power 440 kWh



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+50, −30	136	204	95
2. A Delivered Cost of Fiber,* $/Cunit	+20, −20	32	38	26
B Delivered Cost of Fiber,* $/ADMT	+30, −30	35	46	24
3. Fixed Capital, $ Million	+25, −10	13	16	12
4. Cost of Energy, $/MMBtu	+30, −30	2.0	2.6	1.4

*2A—Virgin, 2B—Average Secondary Fiber Cost

FIGURE IX–K–2 SENSITIVITY OF THE MANUFACTURING COST OF ROOFING FELT TO KEY VARIABLES

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L. MARKET PULP

Investment, operating cost, and profitability estimates have been prepared for market pulp from virgin and from secondary fiber. Because (a) the properties of the two are dissimilar and (b) there is little commercial experience to validate the cost/performance characteristics of market pulp from waste paper, we did not make a direct cost comparison of these two products.

1. Virgin Fiber (Bleached Kraft)

Four economic models were prepared for bleached kraft market pulp--two for softwood and hardwood in a Southeast location and another two for these wood species in a Northeast location. The key cost variables--pulpwood costs (as affected by the delivered cost of wood and weight per unit), and utility costs--were judged to be sufficiently different in these two regions to warrant direct economic comparison. The sample calculations provide a convenient reference point to assess the economic merit of substituting secondary fiber and also provide a means of calculating the cost of slush pulp used in the previously reported economic models. The investment and operating costs for pulp drying were deleted from the market pulp cost calculations to derive the cost of slush pulp (see Section VIII-M). The presentation of these models includes sensitivity analysis of key process variables, the effect of scale of operation upon investment and operating cost, and estimated return on investment (ROI) calculations.

We have used the same figure for plant investment regardless of its location. In practice, there would be a difference of about 2-3%, principally in lower cost for structures in the Southeast; on the other hand, a southern mill would have the additional investment of about $0.5 million for turpentine and tall oil recovery. Since the possible difference in cost between locations is well within the precision of cost investment estimates presented in the analysis, it is not shown.

Table IX-L-1 compares the costs of the softwood models. The supporting cost calculation reveals that the principal saving in the southern mill is its lower pulpwood cost; utility costs, while significantly higher on a unit energy basis for the Northeast mill, are significantly less important than pulpwood costs.

Table IX-L-6 compares the costs of the hardwood pulp mills. In this case, the delivered cost of wood is about the same; hence, the total delivered cost and ROI for the two locations are about the same. In practice, the competition for hardwood in some of the southern locations has driven the price higher than in some of the Northeast locations; hence, the ROI is in some instances more favorable in the Northeast.

TABLE IX-L-1

Economic Comparison of Bleached Kraft Softwood Pulp Manufacture

Functional Group	Market Pulp	
Grade	Bleached Kraft Softwood 88-92 GE Brightness	
Basis Weight	N.A.	
Fiber Furnish	100% Virgin	
Plant Size (MT/DAY)	730	
Plant Location	Southeast	Northeast
Plant Specifics	Integrated	Integrated
Total Fixed Capital ($ Million)	140	140
($000/Daily Ton)	192	192
Total Delivered Cost ($/ADMT)	203.0	237.1
Raw Materials ($/MT, delivered)	73.1	107.9
Conversion ($/MT)	44.2	51.6
Capital-Related ($/MT)	42.7	42.7
Sales Cost (less freight) ($/MT)	13.0	13.0
Freight in ($/MT Product)*	16.9	21.2
Freight out ($/MT Product)	30.0	22.0
Selling Price ($/ADMT)	325	325
Return on Fixed Capital, pre-tax (%)	22.0	15.8

*Not included in total delivered cost

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TABLE IX-L-2

DESIGN BASIS

Functional Group	Market Pulp	Process	Continuous kraft pulping, C-E-D-E-D bleaching
Grade	Bleached SW kraft	Fiber Furnish	100% virgin fiber (softwood from 50/50 roundwood/chips)
Basis Weight	n.a.	Pulp Yield	42%
Production	730 ADMT/day; 252,000 ADMT/yr	Mill Location	Southeast
Net Operating Days	345/yr	Boundary Limits	Wood preparation through market pulp production

CAPITAL REQUIREMENTS* (\$000)

Physical Plant	127,700	
Other Fixed Capital	12,800	
Total Fixed Capital		140,000
Working Capital		13,000
Total Capital Required		153,000

ENERGY REQUIREMENTS (per ADMT)

	Steam (kg)	Power (kWh)
Wood Preparation	–	120
Pulping	1,970	130
Bleaching	3,620	100
Drying	3,000	130
Power & Steam Gen. (incl. recovery & liquor prep.)	1,970	200
Effluent Treatment	–	20
Misc. & Auxiliaries	1,480	30
Total	12,040	730

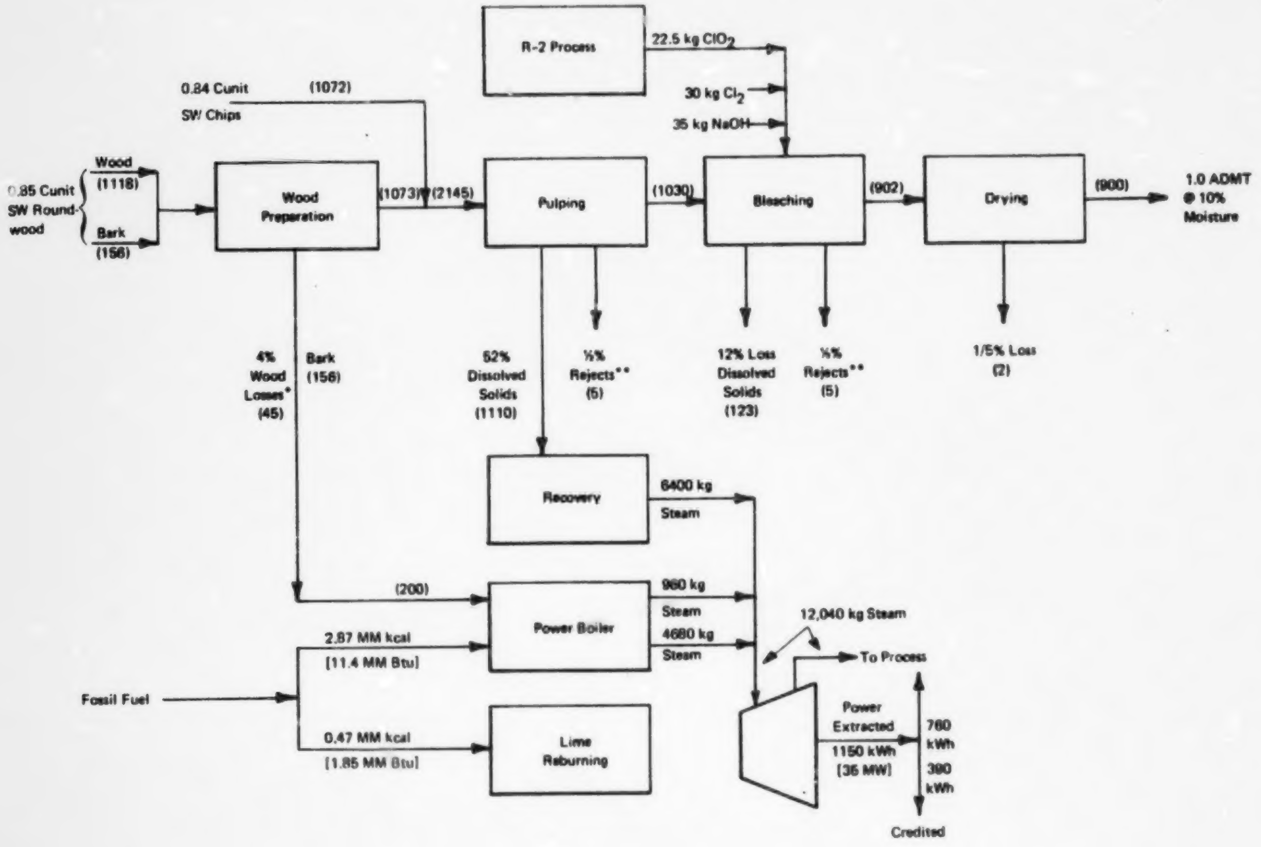
OPERATING COST* (\$/ADMT)

Fiber Furnish	54.1	
Other Raw Materials	19.0	
Total Raw Materials Cost		73.1
Labor + Fringe @ 32% of Hourly Rate	18.8	
Supplies	12.0	
Energy	8.6	
Factory Overhead	4.9	
Total Conversion Costs		44.2
Capital-Related Costs		42.7
• Total Factory Operating Cost		160.0 (\$145.1/ADST)
GS&A	13.0	
Freight Out	30.0	
Total Cost of Sales		43.0
• Total Delivered Cost		203.0 (\$184.1/ADST)

*Totals may not add due to rounding.

FIGURE IX-L-1

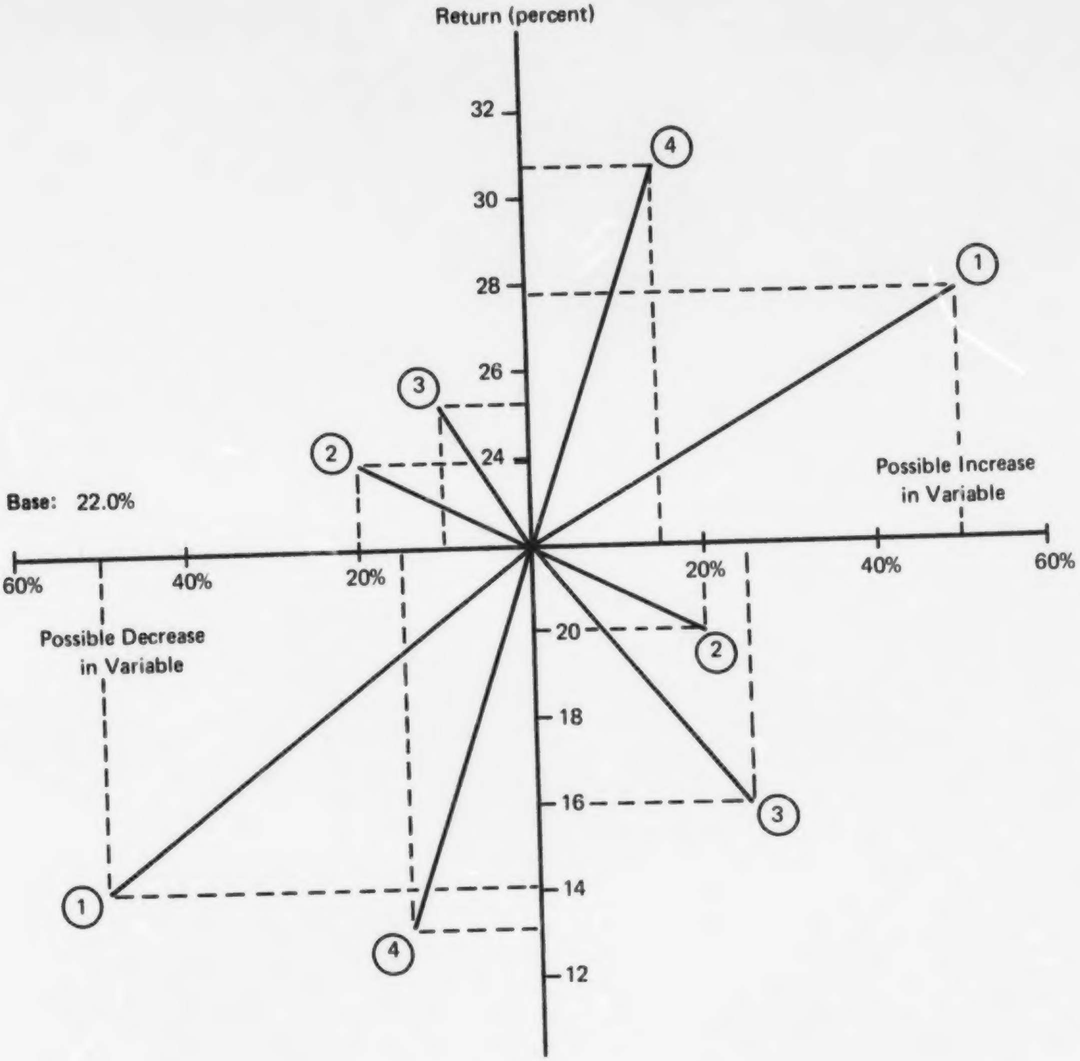
MATERIAL AND ENERGY BALANCE
(Basis: 1 ADMT market pulp)


R-2 Process
22.5 kg ClO_2
30 kg Cl_2
35 kg NaOH
0.84 Cunit SW Chips
(1072)
0.85 Cunit SW Round-wood
Wood (1118)
Bark (156)
Wood Preparation
(1073)
(2145)
Pulping
(1030)
Bleaching
(902)
Drying
(900)
1.0 ADMT @ 10% Moisture
4% Wood Losses* (45)
Bark (156)
52% Dissolved Solids (1110)
½% Rejects** (5)
12% Loss Dissolved Solids (123)
½% Rejects** (5)
1/5% Loss (2)
Recovery
6400 kg Steam
(200)
Power Boiler
960 kg Steam
4680 kg Steam
12,040 kg Steam
To Process
Fossil Fuel
2.87 MM kcal [11.4 MM Btu]
0.47 MM kcal [1.85 MM Btu]
Lime Reburning
Power Extracted 1150 kWh [36 MW]
760 kWh
390 kWh
Credited

( ) Indicates BD kg

*2% loss on barking (suitable for fuel recovery) + 2% loss on chipping (suitable for fuel or fiber recovery)

**Fiber loss suitable for recovery in lower-grade products



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+50, −50	730	1100	365
2. Delivered Cost of Fiber, $/Cunit	+20, −20	32	38	26
3. Fixed Capital, $ Million	+25, −10	140	175	126
4. Selling Price, $/ADMT	+15, −15	325	276	374

FIGURE IX–L–2 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF BLEACHED SOFTWOOD KRAFT MARKET PULP (SOUTHEAST) TO KEY VARIABLES

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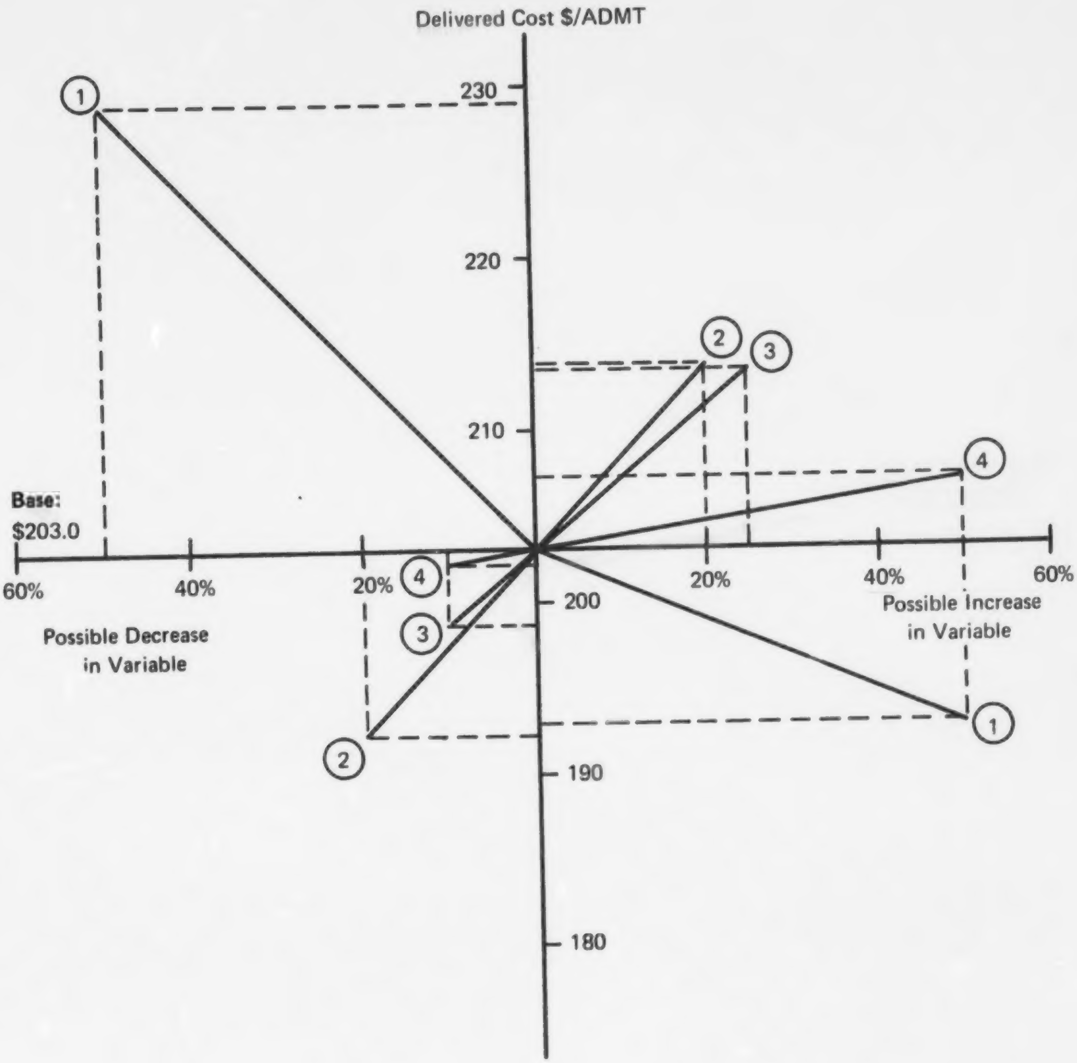


KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+50, −50	730	1100	365
2. Delivered Cost of Fiber, $/Cunit	+20, −20	32	38	26
3. Fixed Capital, $ Million	+25, −10	140	175	126
4. Cost of Energy, $/MMBtu	+50, −10	1.0	1.5	0.9

FIGURE IX–L–3 SENSITIVITY OF THE MANUFACTURING COST OF BLEACHED SOFTWOOD KRAFT MARKET PULP (SOUTHEAST) TO KEY VARIABLES

TABLE IX-L-4

DESIGN BASIS

Functional Group	Market Pulp	Process	Continuous kraft pulping, C-E-D-E-D bleaching
Grade	Bleached SW kraft	Fiber Furnish	100% virgin fiber (softwood from 50/50 roundwood/ chips
Basis Weight	n.a.	Pulp Yield	42%
Production	730 ADMT/day; 252,000 ADMT/yr	Mill Location	Northeast
Net Operating Days	345/yr	Boundary Limits	Wood preparation through market pulp production

CAPITAL REQUIREMENTS* ($000)

Physical Plant	127,700	
Other Fixed Capital	12,800	
Total Fixed Capital		140,000
Working Capital		15,000
Total Capital Required		155,000

ENERGY REQUIREMENTS (per ADMT)

	Steam (kg)	Power (kWh)
Wood Preparation	–	120
Pulping	1,970	130
Bleaching	3,620	100
Drying	3,000	130
Power & Steam Gen. (incl. recovery & liquor prep.)	1,970	200
Effluent Treatment	–	20
Misc. & Auxiliaries	1,480	30
Total	12,040	730

OPERATING COST* ($/ADMT)

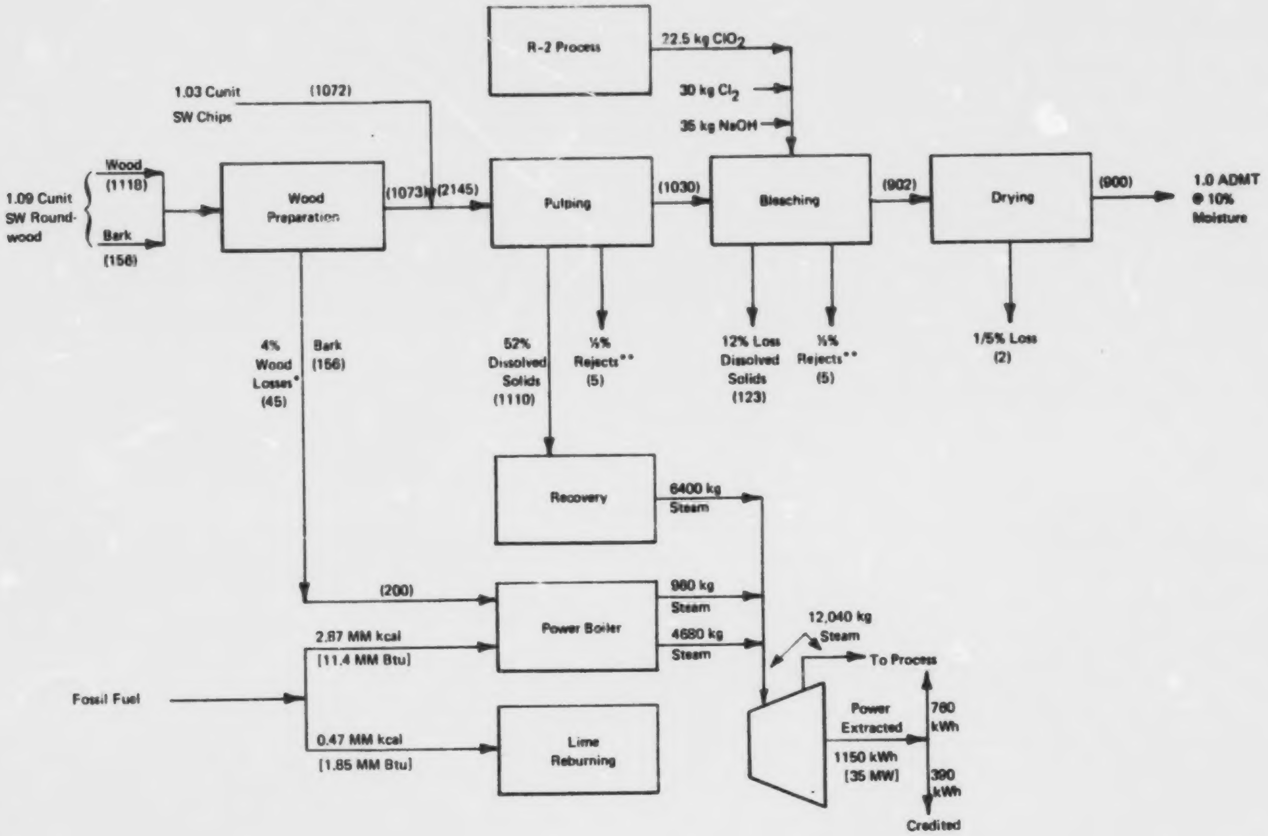
Fiber Furnish	86.9	
Other Raw Materials	21.0	
Total Raw Materials Cost		107.9
Labor + Fringe @ 32% of Hourly Rate	16.5	
Supplies	12.0	
Energy	18.3	
Factory Overhead	4.9	
Total Conversion Costs		51.6
Capital-Related Costs		42.7
• Total Factory Operating Cost		202.1 ($183.3/ADST)
GS&A	13.0	
Freight Out	22.0	
Total Cost of Sales		35.0
• Total Delivered Cost		237.1 ($215.0/ADST)

*Totals may not add due to rounding.

FIGURE IX-L-4

MATERIAL AND ENERGY BALANCE

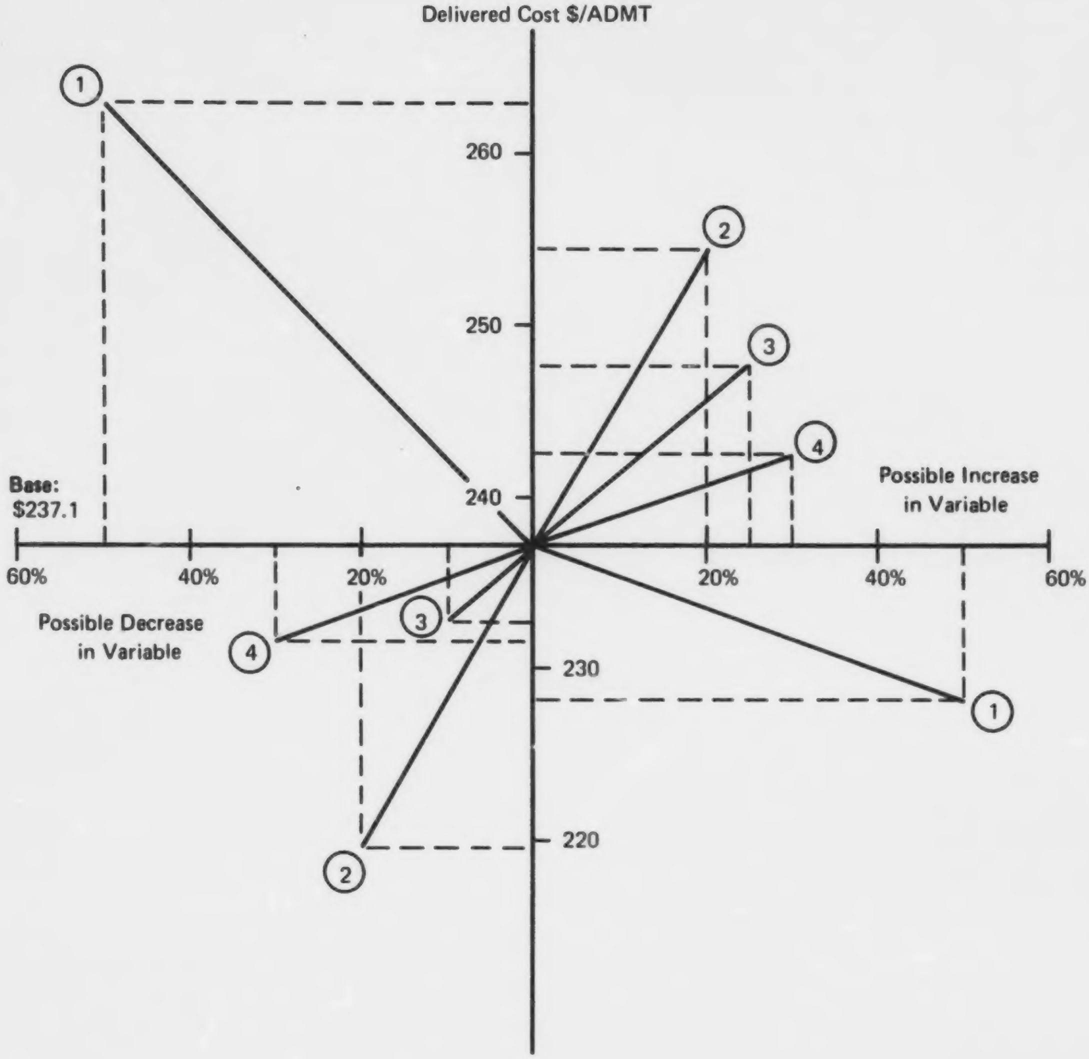
(Basis: 1 ADMT market pulp)


R-2 Process
72.5 kg ClO_2
30 kg Cl_2
35 kg NaOH
1.03 Cunit
SW Chips
(1072)
1.09 Cunit
SW Round-
wood
Wood
(1118)
Bark
(156)
Wood
Preparation
(1073)
(2145)
Pulping
(1030)
Bleaching
(902)
Drying
(900)
1.0 ADMT
@ 10%
Moisture
4%
Wood
Losses*
(45)
Bark
(156)
52%
Dissolved
Solids
(1110)
½%
Rejects**
(5)
12% Loss
Dissolved
Solids
(123)
½%
Rejects**
(5)
1/5% Loss
(2)
Recovery
6400 kg
Steam
(200)
Power Boiler
960 kg
Steam
4680 kg
Steam
12,040 kg
Steam
To Process
2.87 MM kcal
[11.4 MM Btu]
Fossil Fuel
0.47 MM kcal
[1.85 MM Btu]
Lime
Reburning
Power
Extracted
1150 kWh
[35 MW]
760
kWh
390
kWh
Credited

( ) Indicates BD kg

*2% loss on barking (suitable for fuel recovery) + 2% loss on chipping (suitable for fuel or fiber recovery)

**Fiber loss suitable for recovery in lower grade products



KEY VARIABLES		Percent Variation	Best Guess	Possible High	Possible Low
1.	Scale of Operations, MTPD	+50, −50	730	1100	365
2.	Delivered Cost of Fiber, $/Cunit	+20, −20	41	49	33
3.	Fixed Capital, $ Million	+25, −10	140	175	126
4.	Cost of Energy, $/MMBtu	+30, −30	2.0	2.6	1.4

FIGURE IX–L–5 SENSITIVITY OF THE MANUFACTURING COST OF BLEACHED SOFTWOOD KRAFT MARKET PULP (NORTHEAST) TO KEY VARIABLES

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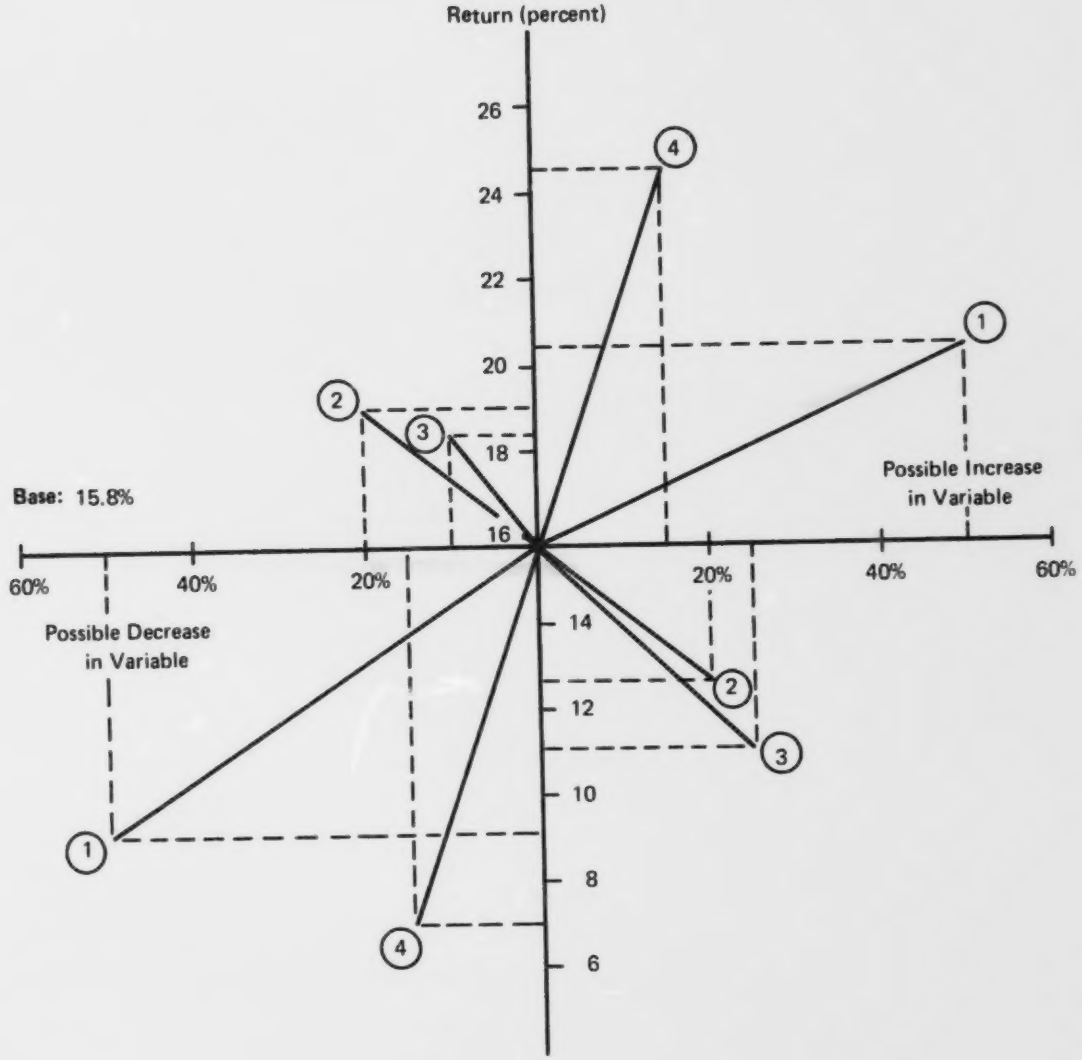


KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+50, −50	730	1100	365
2. Delivered Cost of Fiber, $/Cunit	+20, −20	41	49	33
3. Fixed Capital, $ Million	+25, −10	140	175	126
4. Selling Price, $/ADMT	+15, −15	325	374	276

FIGURE IX-L-6 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF BLEACHED SOFTWOOD KRAFT MARKET PULP (NORTHEAST) TO KEY VARIABLES

TABLE IX-L-6

Economic Comparison of Bleached Kraft Hardwood Pulp Manufacture

Functional Group	Market Pulp	
Grade	Bleached Kraft Hardwood 88-90 GE Brightness	
Basis Weight	N.A.	
Fiber Furnish	100% Virgin	
Plant Size (MT/DAY)	730	
Plant Location	Southeast	Northeast
Plant Specifics	Integrated	Integrated
Total Fixed Capital ($ Million)	132	132
($000/Daily Ton)	181	181
Total Delivered Cost ($/ADMT)	186.2	201.6
Raw Materials ($/MT, delivered)	58.3	73.2
Conversion ($/MT)	43.6	52.5
Capital-Related ($/MT)	41.4	41.4
Sales Cost (less freight) ($/MT)	13.0	12.6
Freight in ($/MT Product)*	14.9	14.9
Freight out ($/MT Product)	30.0	22.0
Selling Price ($/ADMT)	320	320
Return on Fixed Capital, pre-tax (%)	25.5	22.6

*Not included in total delivered cost

TABLE IX-L-7

DESIGN BASIS

Functional Group	Market Pulp	Process	Continuous kraft pulping, C-E-D-E-D bleaching
Grade	Bleached HW kraft	Fiber Furnish	100% virgin fiber (hardwood from 50/50 roundwood/chips)
Basis Weight	n.a.	Pulp Yield	46%
Production	730 ADMT/day; 252,000 ADMT/yr	Mill Location	Southeast
Net Operating Days	345/yr	Boundary Limits	Wood preparation through market pulp production

CAPITAL REQUIREMENTS
($000)

Physical Plant	120,000	
Other Fixed Capital	12,000	
Total Fixed Capital		132,000
Working Capital		12,000
Total Capital Required		144,000

ENERGY REQUIREMENTS
(per ADMT)

	Steam (kg)	Power (kWh)
Wood Preparation	–	110
Pulping	1,810	120
Bleaching	3,290	90
Drying	3,000	130
Power & Steam Gen. (incl. recovery & liquor prep.)	1,810	180
Effluent Treatment	–	20
Misc. & Auxiliaries	1,350	60
Total	11,260	710

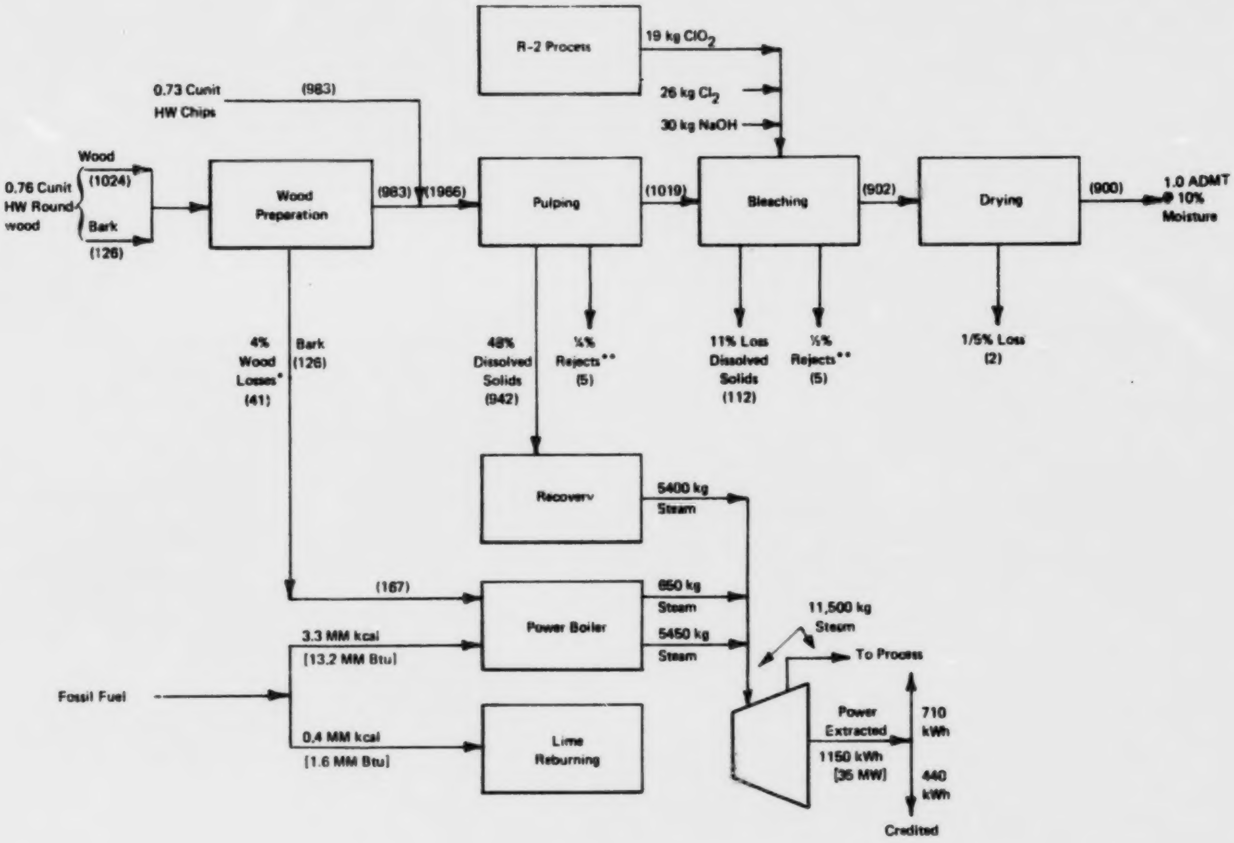
OPERATING COST*
($/ADMT)

Fiber Furnish	40.2	
Other Raw Materials	18.0	
Total Raw Materials Cost		58.3
Labor + Fringe @ 32% of Hourly Rate	17.4	
Supplies	12.0	
Energy	9.5	
Factory Overhead	4.8	
Total Conversion Costs		43.6
Capital-Related Costs		41.4
• Total Factory Operating Cost		143.2 ($129.9/ADST)
GS&A	13.0	
Freight Out	30.0	
Total Cost of Sales		43.0
• Total Delivered Cost		186.2 ($168.9/ADST)

*Totals may not add due to rounding.

FIGURE IX-L-7

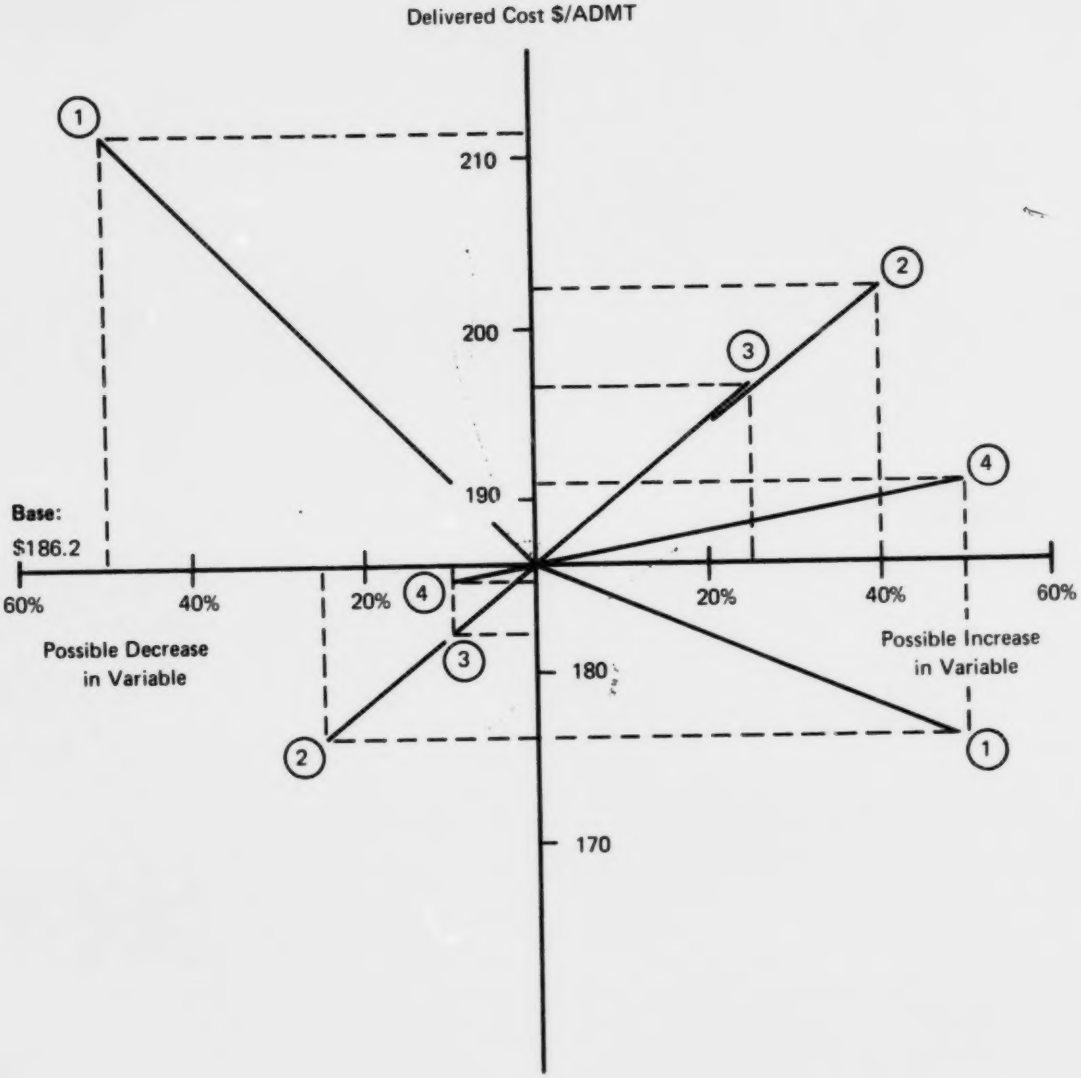
MATERIAL AND ENERGY BALANCE
(Basis: 1 ADMT market pulp)


R-2 Process
19 kg ClO_2
26 kg Cl_2
30 kg NaOH
0.73 Cunit HW Chips
(983)
0.76 Cunit HW Round wood
Wood (1024)
Bark (126)
Wood Preparation
(983)
(1966)
Pulping
(1019)
Bleaching
(902)
Drying
(900)
1.0 ADMT @ 10% Moisture
4% Wood Losses* (41)
Bark (126)
48% Dissolved Solids (942)
¼% Rejects** (5)
11% Loss Dissolved Solids (112)
½% Rejects** (5)
1/5% Loss (2)
Recovery
5400 kg Steam
(167)
Power Boiler
650 kg Steam
5450 kg Steam
3.3 MM kcal [13.2 MM Btu]
Fossil Fuel
0.4 MM kcal [1.6 MM Btu]
Lime Reburning
11,500 kg Steam
To Process
Power Extracted
1150 kWh [35 MW]
710 kWh
440 kWh
Credited

( ) Indicates BD kg

*2% loss on barking (suitable for fuel recovery) + 2% loss on chipping (suitable for fuel or fiber recovery)

** Fiber loss suitable for recovery in lower-grade products



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+50, −50	730	1100	365
2. Delivered Cost of Fiber, $/Cunit	+20, −20	27	32	22
3. Fixed Capital, $ Million	+25, −10	132	165	119
4. Cost of Energy, $/MMBtu	+50, −10	1.0	1.5	0.9

FIGURE IX–L–8 SENSITIVITY OF THE MANUFACTURING COST OF BLEACHED HARDWOOD KRAFT MARKET PULP (SOUTHEAST) TO KEY VARIABLES

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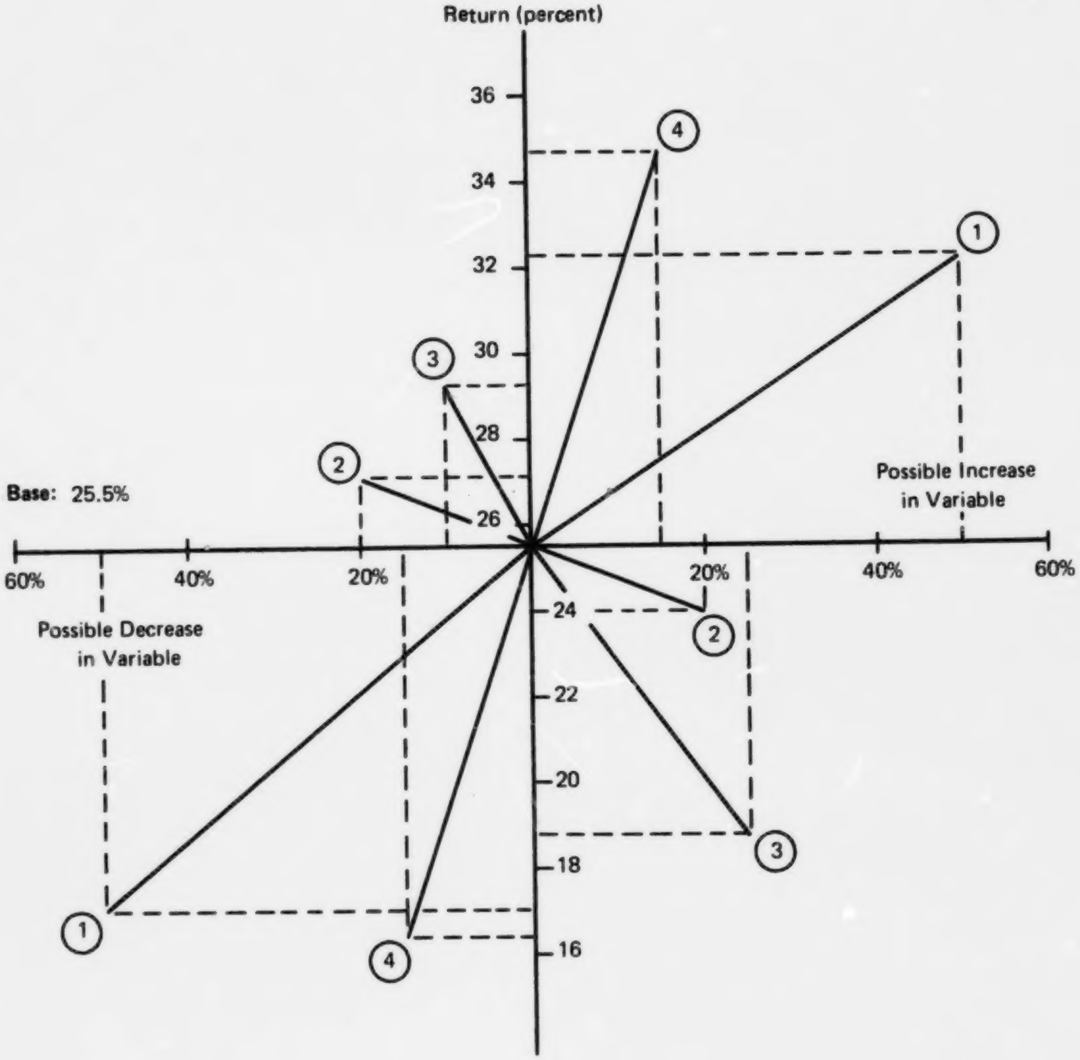


KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+50, −50	730	1100	365
2. Delivered Cost of Fiber, $/Cunit	+20, −20	27	32	22
3. Fixed Capital, $ Million	+25, −10	132	165	119
4. Selling Price, $/ADMT	+15, −15	320	368	272

FIGURE IX–L–9 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF BLEACHED HARDWOOD KRAFT MARKET PULP (SOUTHEAST) TO KEY VARIABLES

TABLE IX-L-9

DESIGN BASIS

Functional Group	Market Pulp	Process	Continuous kraft pulping, C-E-D-E-D bleaching
Grade	Bleached HW kraft	Fiber Furnish	100% virgin fiber (hardwood from 50/50 roundwood/chips)
Basis Weight	n.a.	Pulp Yield	46%
Production	730 ADMT/day; 252,000 ADMT/yr	Mill Location	Northeast
Net Operating Days	345/yr	Boundary Limits	Wood preparation through market pulp production

CAPITAL REQUIREMENTS ($000)

Physical Plant	120,000	
Other Fixed Capital	12,000	
Total Fixed Capital		132,000
Working Capital		12,000
Total Capital Required		144,000

ENERGY REQUIREMENTS (per ADMT)

	Steam (kg)	Power (kWh)
Wood Preparation	–	110
Pulping	1,810	120
Bleaching	3,290	90
Drying	3,000	130
Power & Steam Gen. (incl. recovery & liquor prep.)	1,810	180
Effluent Treatment	–	20
Misc. & Auxiliaries	1,350	60
Total	11,260	710

OPERATING COST* ($/ADMT)

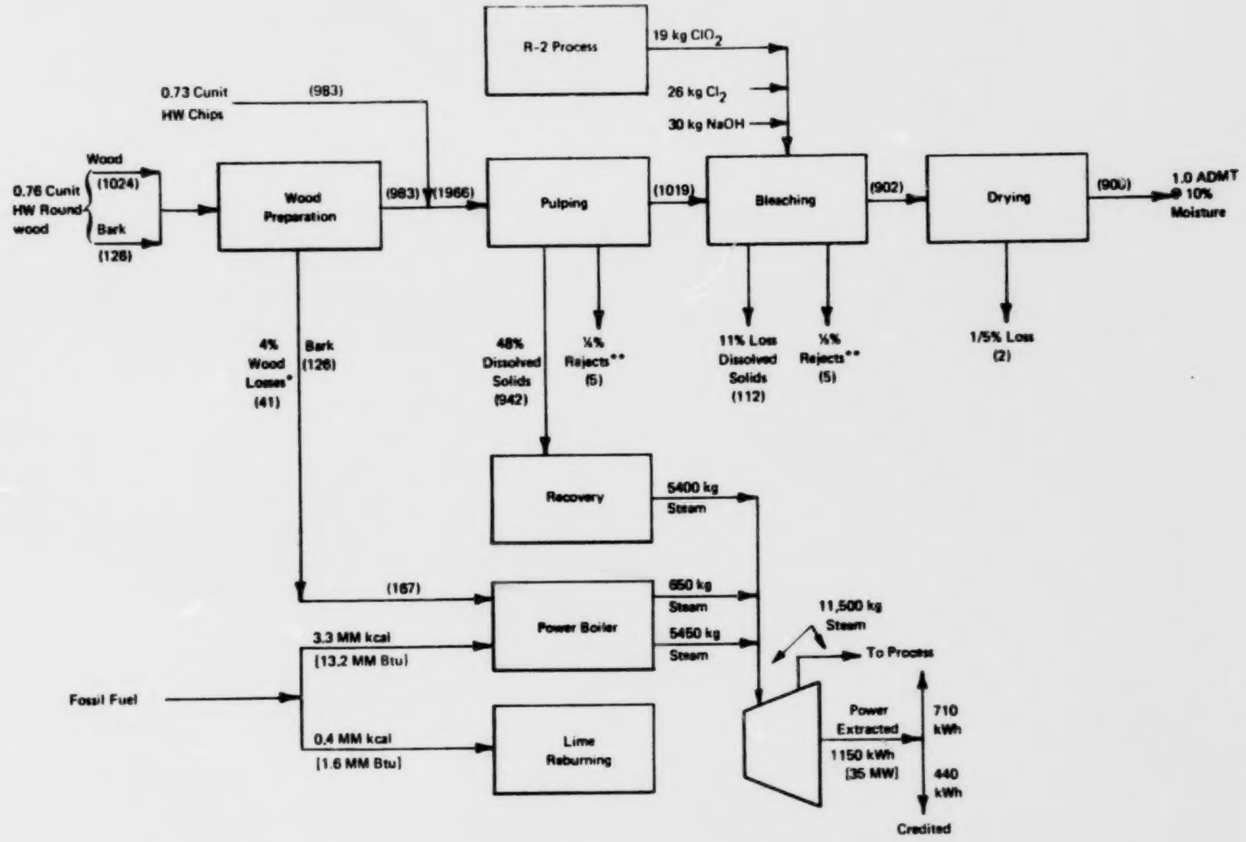
Fiber Furnish	55.1	
Other Raw Materials	18.0	
Total Raw Materials Cost		73.2
Labor + Fringe @ 32% of Hourly Rate	16.1	
Supplies	12.0	
Energy	20.3	
Factory Overhead	4.2	
Total Conversion Costs		52.5
Capital-Related Costs		41.4
• Total Factory Operating Cost		167.0 ($151.5/ADST)
GS&A	12.6	
Freight Out	22.0	
Total Cost of Sales		34.6
• Total Delivered Cost		201.6 ($182.9/ADST)

*Totals may not add due to rounding.

FIGURE IX-L-10

MATERIAL AND ENERGY BALANCE

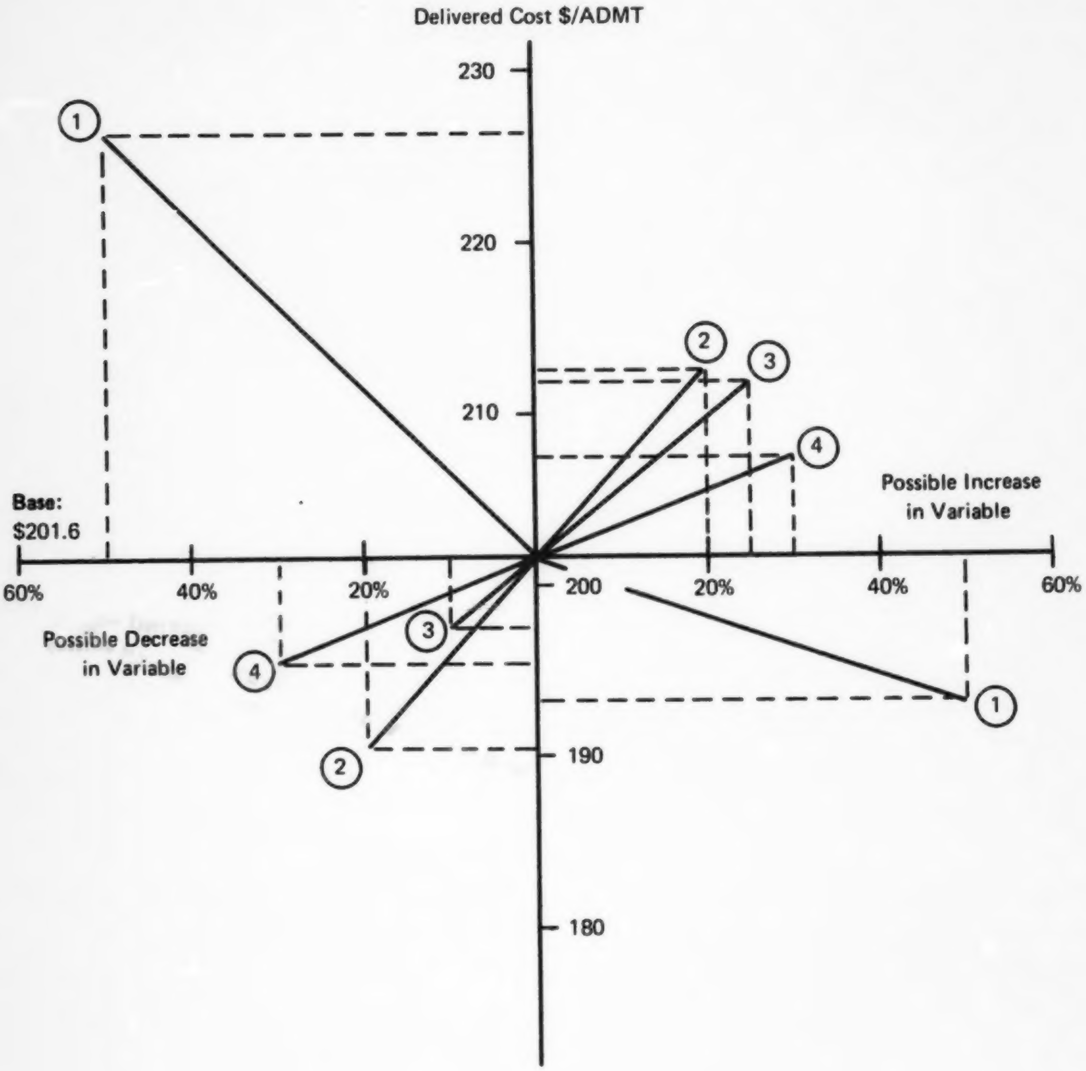
(Basis: 1 ADMT market pulp)


R-2 Process
19 kg ClO_2
26 kg Cl_2
30 kg NaOH
0.73 Cunit
HW Chips
(983)
Wood
(1024)
0.76 Cunit
HW Round-
wood
Bark
(126)
Wood
Preparation
(983)
(1966)
Pulping
(1019)
Bleaching
(902)
Drying
(900)
1.0 ADMT
@ 10%
Moisture
4%
Wood
Losses*
(41)
Bark
(126)
48%
Dissolved
Solids
(942)
¼%
Rejects**
(5)
11% Loss
Dissolved
Solids
(112)
½%
Rejects**
(5)
1/5% Loss
(2)
Recovery
5400 kg
Steam
(167)
Power Boiler
650 kg
Steam
5450 kg
Steam
11,500 kg
Steam
To Process
3.3 MM kcal
[13.2 MM Btu]
Fossil Fuel
0.4 MM kcal
[1.6 MM Btu]
Lime
Reburning
Power
Extracted
1150 kWh
[35 MW]
710
kWh
440
kWh
Credited

( ) Indicates BD kg

*2% loss on barking (suitable for fuel recovery) + 2% loss on chipping (suitable for fuel or fiber recovery)

**Fiber loss suitable for recovery in lower-grade products



KEY VARIABLES		Percent Variation	Best Guess	Possible High	Possible Low
1.	Scale of Operations, MTPD	+50, −50	730	1100	365
2.	Delivered Cost of Fiber, $/Cunit	+20, −20	37	44	30
3.	Fixed Capital, $ Million	+25, −10	132	165	119
4.	Cost of Energy, $/MMBtu	+30, −30	2.0	2.6	1.4

FIGURE IX–L–11 SENSITIVITY OF THE MANUFACTURING COST OF BLEACHED HARDWOOD KRAFT MARKET PULP (NORTHEAST) TO KEY VARIABLES

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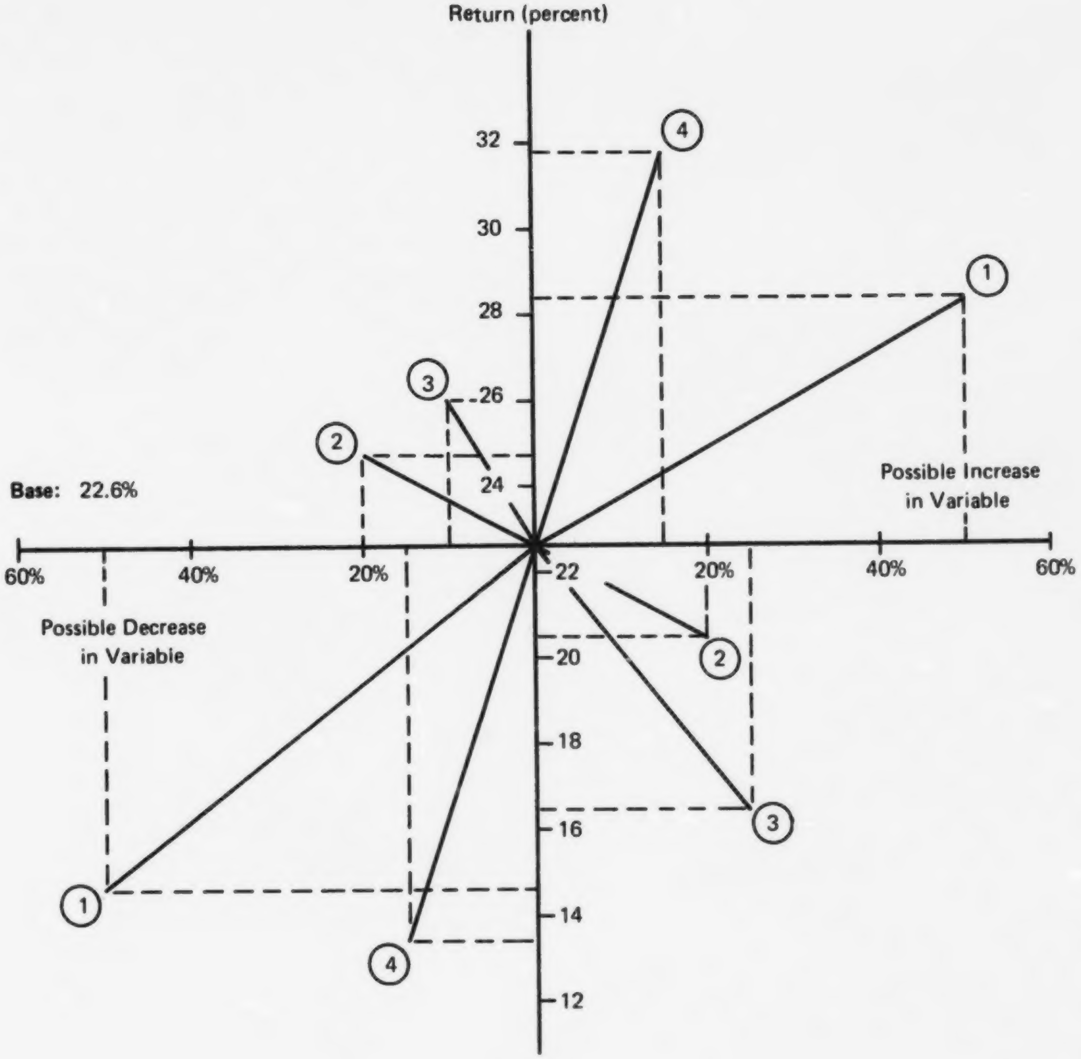


KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+50, −50	730	1100	365
2. Delivered Cost of Fiber, $/Cunit	+20, −20	37	44	30
3. Fixed Capital, $ Million	+25, −10	132	165	119
4. Selling Price, $/MDMT	+15, −15	320	368	272

FIGURE IX–L–12 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF BLEACHED HARDWOOD KRAFT MARKET PULP (NORTHEAST) TO KEY VARIABLES

L. MARKET PULP (cont'd)

2. Secondary Fiber (Unbleached Kraft from OCC)

A direct cost comparison of virgin unbleached softwood kraft pulp with unbleached kraft recovered from OCC is not applicable, because:

(a) Unbleached kraft market pulp from OCC would contain one-third NSSC pulp, which has been demonstrated to lower the strength characteristics of the kraft pulp.

(b) The kraft fiber recovered from OCC is a board-grade pulp (52% yield), for which there is no established price. The closest competitive material is unbleached softwood market pulp.

(c) Unbleached market pulp would be in direct competition with--and have essentially the same quality as--double kraft lined corrugated cuttings, which are currently priced at $70 to $80/ADMT. (Processing of this paper stock would not require an AD system such as has been included in this cost calculation.)

Nevertheless, as there has been considerable discussion recently regarding the economic feasibility of making market pulp from OCC, we have developed preliminary investment, operating cost, and profitability estimates for this material.

The investment estimate presented here is based upon well-known technology. Therefore, we believe it is within the budget estimating accuracy of + 25% and -10% (i.e., the estimate could be low by 25% or high by 10%). The variation could be due to imprecision of the cost estimate or differences in the design concept. Similarly, the operating cost can be calculated with reasonable accuracy because the manufacture of pulp from OCC is based upon established technology. Clearly, the single most important variable is the delivered cost of OCC to the plant and not a process variable, as shown in the sensitivity analysis.

On the other hand, calculation of ROI is not as readily defined, because there is no established price for this product in the market. In the absence of a published list or market price, we calculated one based upon the estimated value of the constituent materials. We assumed a value of $204/ADMT for linerboard-grade kraft pulp (kraft linerboard has a market price of $200/MDMT) and $140/ADMT for NSSC pulp (semi-chemical corrugating medium has a price of $190/MDMT). We also assumed a 10% discount for recycled fiber.

Using a 2:1 ratio of kraft pulp to NSSC, we derived the value of OCC as follows:

Component	Composition (%)	Value ($/ADMT)	Weighted Average Value ($/ADMT)
Unbleached kraft pulp	67	204	137
NSSC	33	140	46
		Total	183
Less 10% because it has been recycled			18
		Net	165

On the basis of this derived value, the ROI is about 6%; the price would have to be about $200 per ton to realize 20% ROI (Figure IX-L-15). Obviously, the availability of alternative raw material will influence the actual market value, and thus the ROI, of this product.

To further analyze this product opportunity, we calculated what the plant payout of an on-site slush pulp system would be against the alternative of buying market pulp from OCC. The analysis thus attempts to answer the question "make or buy?" Assuming that a plant payout of three years or less is an acceptable criterion for investment, Figure IX-L-16 shows that the consumption of slush pulp would have to be less than 50 tpd to make it attractive to buy market pulp at $170/ton, or about 100 tons per day to buy pulp at $130/ton. If the need for slush pulp exceeded the 100-tpd level, the corresponding price for market pulp would have to be lower than $130 per ton to make its purchase attractive.

TABLE IX-L-11

DESIGN BASIS

Functional Group	Market Pulp	Process	Asphalt dispersion of OCC, non-integrated
Grade	Unbl. kraft from OCC	Fiber Furnish	100% S/F (OCC)
Basis Weight	n.a.	Pulp Yield	86% AD pulp to AD S/F as rec'd.
Production	300 ADMT/day; 100,000 ADMT/yr	Mill Location	North Central
Net Operating Days	330/yr	Boundary Limits	S/F preparation through market pulp production

CAPITAL REQUIREMENTS* ($000)

Physical Plant	21,600	
Other Fixed Capital	2,200	
Total Fixed Capital		24,000
Working Capital		4,000
Total Capital Required		28,000

ENERGY REQUIREMENTS (per ADMT)

	Steam (kg)	Power (kWh)
Asphalt Dispersion	1,000	100
Drying	4,000	130
Other Process	–	80
Misc. & Auxiliaries	1,000	160
Total	6,000	470

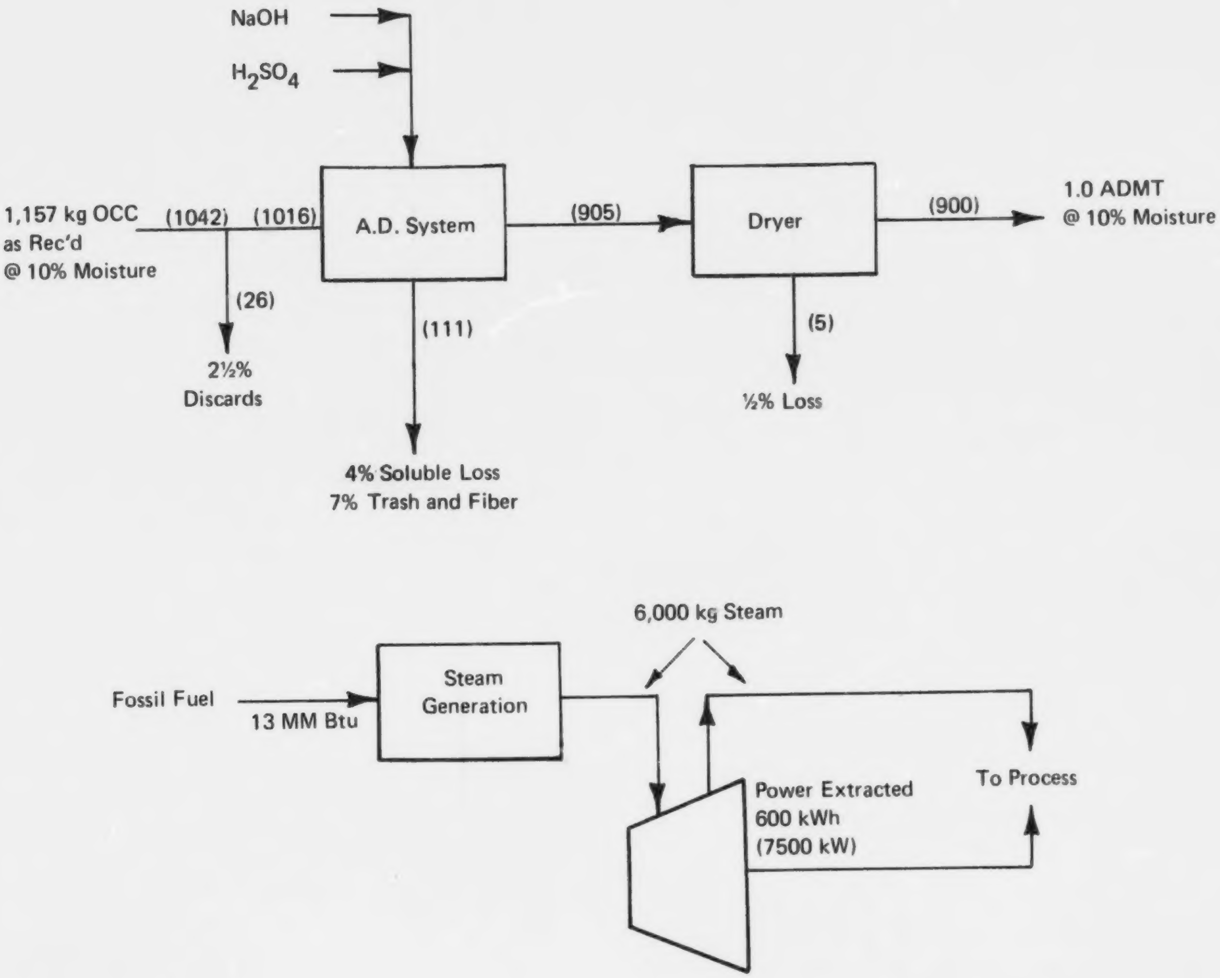
*Totals may not add due to rounding.

OPERATING COST ($/ADMT)

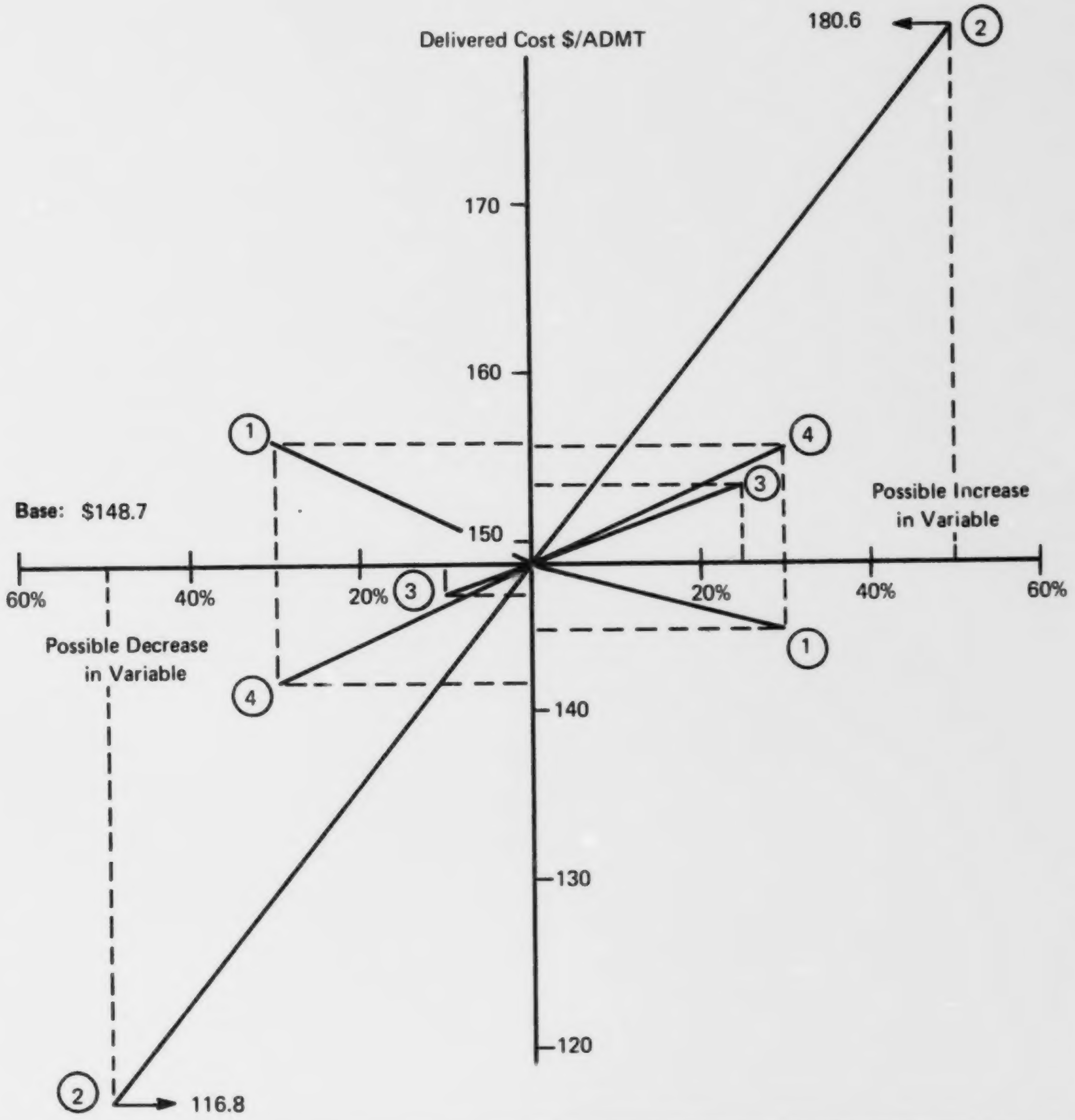
Fiber Furnish	63.8	
Other Raw Materials	3.0	
Total Raw Materials Cost		66.8
Labor + Fringe @ 32% of Hourly Rate	11.2	
Supplies	5.6	
Energy	23.4	
Factory Overhead	5.7	
Total Conversion Costs		45.9
Capital-Related Costs		18.4
● Total Factory Operating Cost		131.1 ($118.9/ADST)
GS&A	5.6	
Freight Out	12.0	
Total Cost of Sales		17.6
● Total Delivered Cost		148.7 ($134.9/ADST)

FIGURE IX-L-13

MATERIAL AND ENERGY BALANCE
(Basis: 1.0 ADMT market pulp)


NaOH
H_2SO_4
1,157 kg OCC
as Rec'd
@ 10% Moisture
(1042)
(1016)
A.D. System
(26)
2½%
Discards
(111)
4% Soluble Loss
7% Trash and Fiber
(905)
Dryer
(5)
½% Loss
(900)
1.0 ADMT
@ 10% Moisture
6,000 kg Steam
Fossil Fuel
13 MM Btu
Steam
Generation
Power Extracted
600 kWh
(7500 kW)
To Process

( ) Indicates BD kg



KEY VARIABLES		Percent Variation	Best Guess	Possible High	Possible Low
1.	Scale of Operations, MTPD	+30, −30	300	390	210
2.	Delivered Cost of Fiber, $/ADMT	+50, −50	55	83	28
3.	Fixed Capital, $ Million	+25, −10	24	30	22
4.	Cost of Energy, $/MMBtu	+30, −30	1.8	2.3	1.3

FIGURE IX–L–14 SENSITIVITY OF THE MANUFACTURING COST OF UNBLEACHED KRAFT MARKET PULP (SECONDARY) TO KEY VARIABLES

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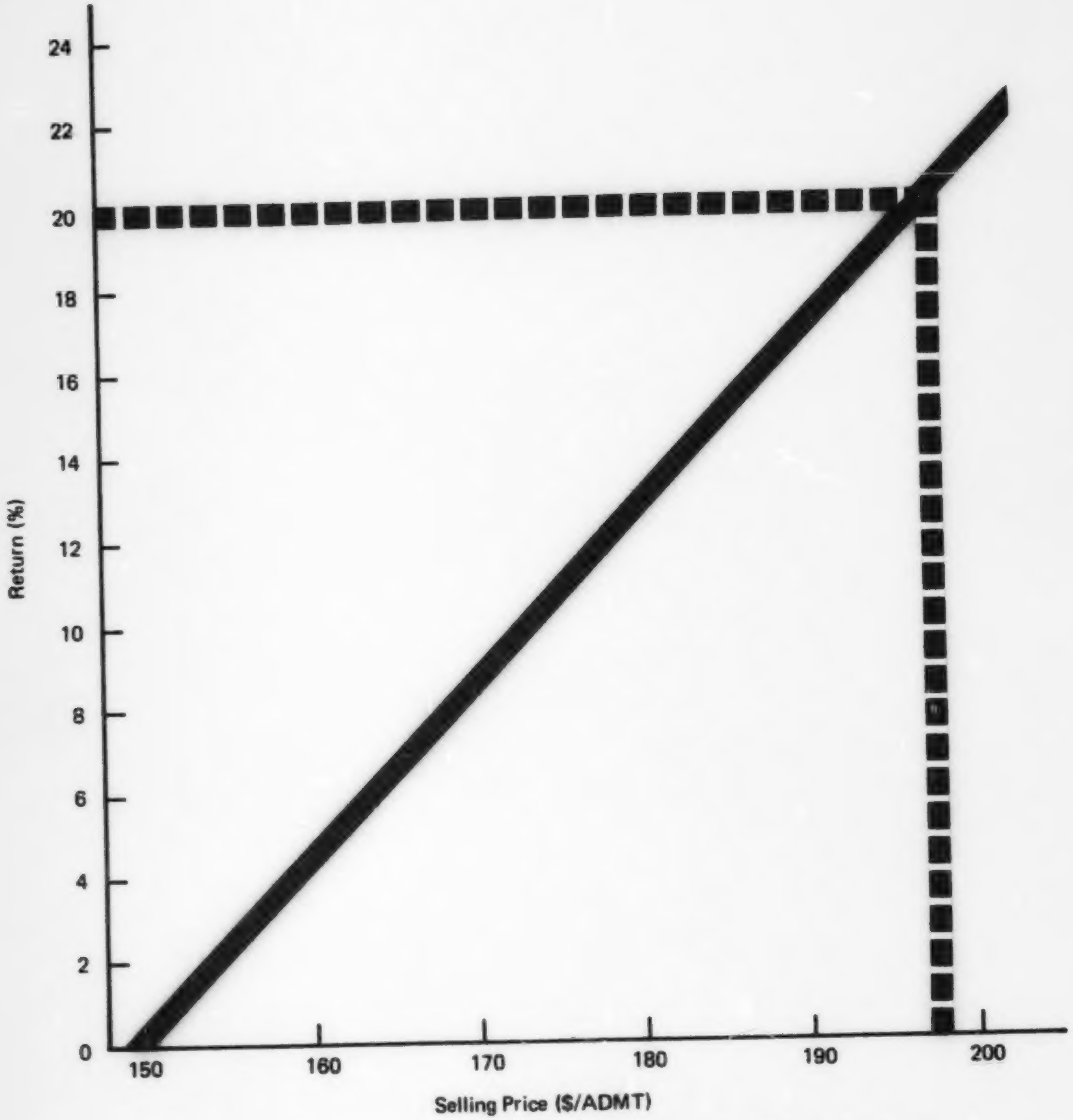


FIGURE IX–L–15 PRE-TAX RETURN ON FIXED CAPITAL VERSUS SELLING PRICE FOR UNBLEACHED KRAFT MARKET PULP (Secondary)

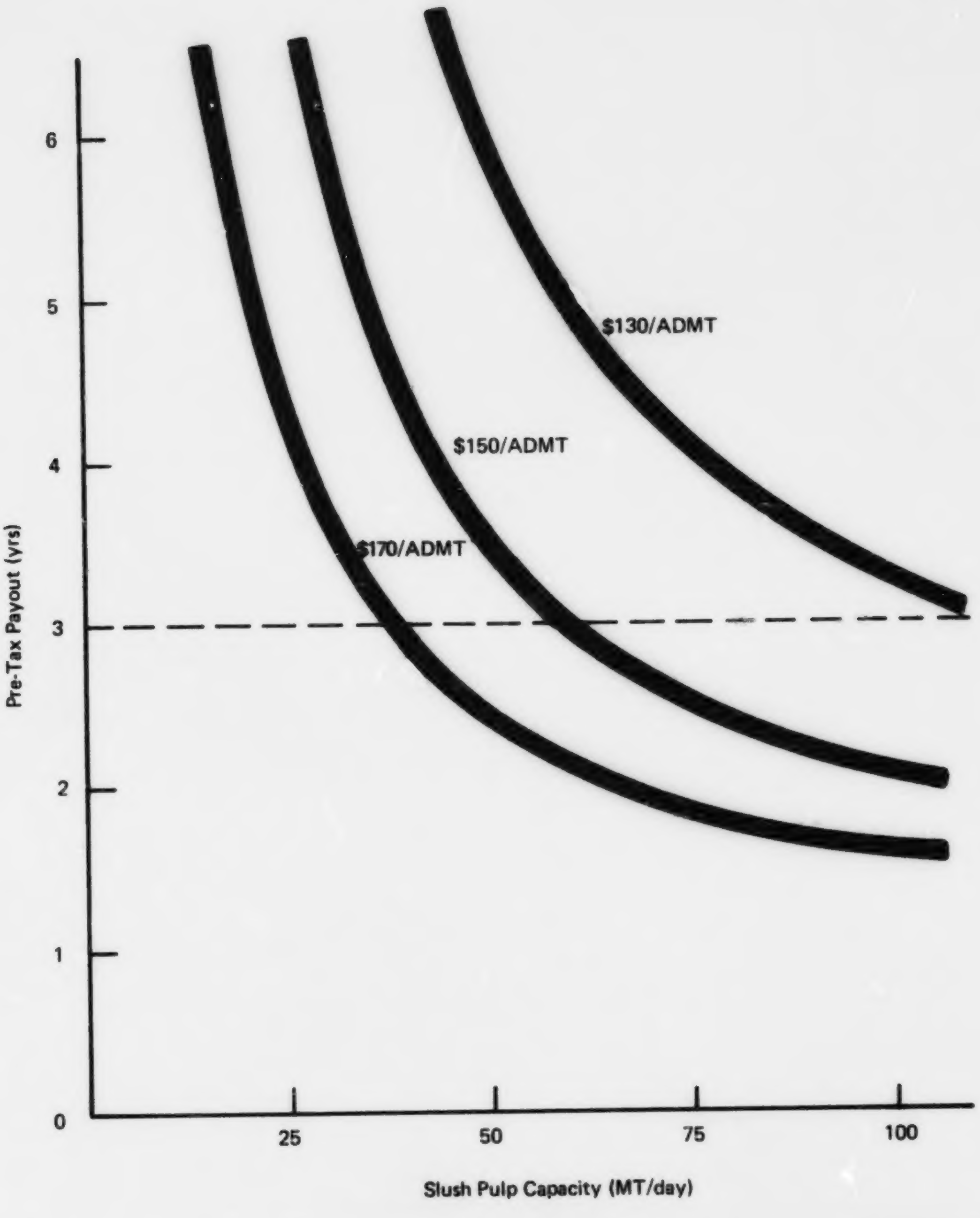


FIGURE IX–L–16 SLUSH PULP FROM OCC (Asphalt Dispersion) – PLANT PAYOUT VERSUS CAPACITY AT VARIOUS SELLING PRICES FOR COMPETITIVE MARKET PULP

L. MARKET PULP (cont'd)

3. Secondary Fiber (Groundwood from Old News)

Newsprint is composed of about 75% groundwood and 25% semi-bleached softwood kraft, or high-yield bisulfite pulp. The technology for the reclamation and deinking of these fibers is well established; hence, there is a sound basis for developing the investment and operating cost for this model. However, as in the case of the previous example, the biggest uncertainty is the profitability of the market pulp mill, since the value of the recovered fiber to a consumer has not been established. We have attempted to respond to that question by determining the cost of an alternative raw material to a mill that might purchase the recovered fiber.

Fixed capital for the selected 300-ADMT/day plant has been estimated at $28 million, corresponding to some $95,000 per daily ton of capacity. The investment excludes on-site power generation facilities, because the potential for obtaining extraction power from the process steam requirements is less than 7500 kW, which we judged to be the minimum size that would be economically attractive.

The total delivered cost is estimated at $164 per ton, and the sensitivity analysis once again demonstrates that the cost of fibrous raw material is the single most important variable. Energy cost, the second key variable, might be reduced by installing on-site power generation facilities, but the plant payout for the incremental investment would have to be determined.

Lacking an established market price for this material--hence the ability to calculate the ROI of the project--we derived a price (see below) based upon the value of the constituent materials less a $5/ton discount because it is a recovered product.

Component	Composition	Value ($/ADMT)		Weighted Average Value ($/ADMT)
Groundwood	75	206		155
Semi-Bleached Softwood	25	320		80
			Total	235
			Less Discount	2
			Net Selling Price	230

The pre-tax ROI based upon this derived price is about 23%. Obviously, the cost and availability of alternative fibrous raw material will influence the market value, and thus the ROI, of this project.

To further analyze this product opportunity, we calculated what the plant payout of an on-site slush pulp operation would be against the alternative of buying market pulp recovered from old news. Assuming that three years or less is an acceptable criterion for investment, Figure IX-L-21 shows that slush pulp consumption would have to be less than 40 tpd to make it attractive to buy market pulp at $230 per ton. Similarly, consumption would have to be less than 60 tpd to make it attractive to buy market pulp at $200/ton.

TABLE IX-L-13

DESIGN BASIS

Functional Group	Market Pulp	Process	Newsprint de-inking, non-integrated
Grade	Groundwood (secondary newsprint)	Fiber Furnish	100% S/F (No. 1 news)
Basis Weight	n.a.	Pulp Yield	83% AD pulp to AD S/F as rec'd.
Production	300 ADMT/day; 100,000 ADMT/yr	Mill Location	Northeast
Net Operating Days	330/yr	Boundary Limits	S/F preparation through market pulp production

CAPITAL REQUIREMENTS* ($000)

Physical Plant	25,100	
Other Fixed Capital	2,500	
Total Fixed Capital		28,000
Working Capital		4,000
Total Capital Required		32,000

ENERGY REQUIREMENTS (per ADMT)

	Steam (kg)	Power (kWh)
De-inking	500	300
Drying	3,000	130
Misc. & Auxiliaries	600	80
Total	4,100	510

*Totals may not add due to rounding.

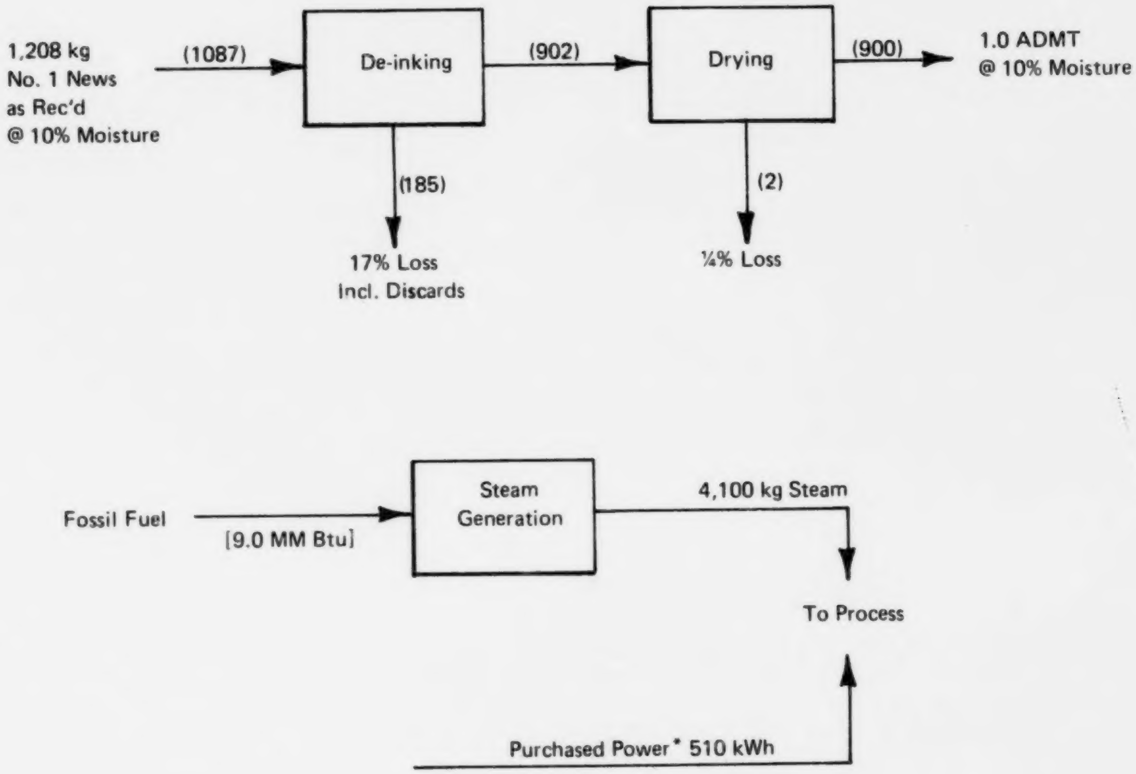
OPERATING COST ($/ADMT)

Fiber Furnish	54.5	
Other Raw Materials	8.6	
Total Raw Materials Cost		63.1
Labor + Fringe @ 32% of Hourly Rate	11.8	
Supplies	8.0	
Energy	28.7	
Factory Overhead	7.0	
Total Conversion Costs		55.5
Capital-Related Costs		21.4
• Total Factory Operating Cost		140.0 ($127.0/ADST)
GS&A	11.6	
Freight Out	12.0	
Total Cost of Sales		23.6
• Total Delivered Cost		163.6 ($148.4/ADST)

FIGURE IX-L-17

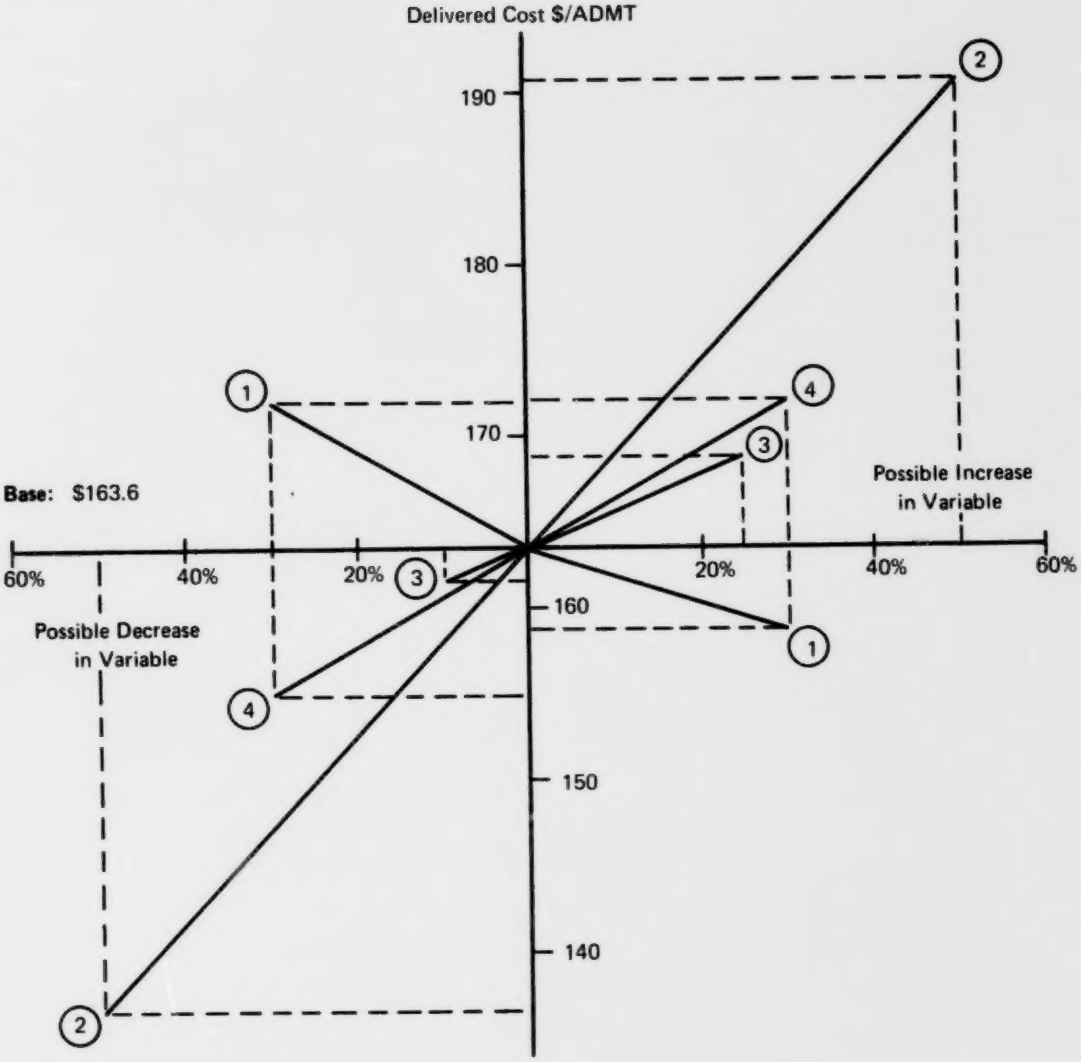
MATERIAL AND ENERGY BALANCE

(Basis: 1.0 ADMT market pulp)


1,208 kg
No. 1 News
as Rec'd
@ 10% Moisture
(1087)
De-inking
(902)
Drying
(900)
1.0 ADMT
@ 10% Moisture
(185)
17% Loss
Incl. Discards
(2)
¼% Loss
Fossil Fuel
[9.0 MM Btu]
Steam
Generation
4,100 kg Steam
To Process
Purchased Power* 510 kWh

*Extraction turbine not used here, as size would be uneconomic (< 7500 kW)

( ) Indicates BD kg



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+30, −30	300	390	210
2. Delivered Cost of Fiber, $/ADMT	+50, −50	45	68	23
3. Fixed Capital, $ Million	+25, −10	28	35	25
4. Cost of Energy, $/MMBtu	+30, −30	2.0	2.6	1.4

FIGURE IX–L–18 SENSITIVITY OF THE MANUFACTURING COST OF GROUNDWOOD MARKET PULP (SECONDARY NEWSPRINT) TO KEY VARIABLES

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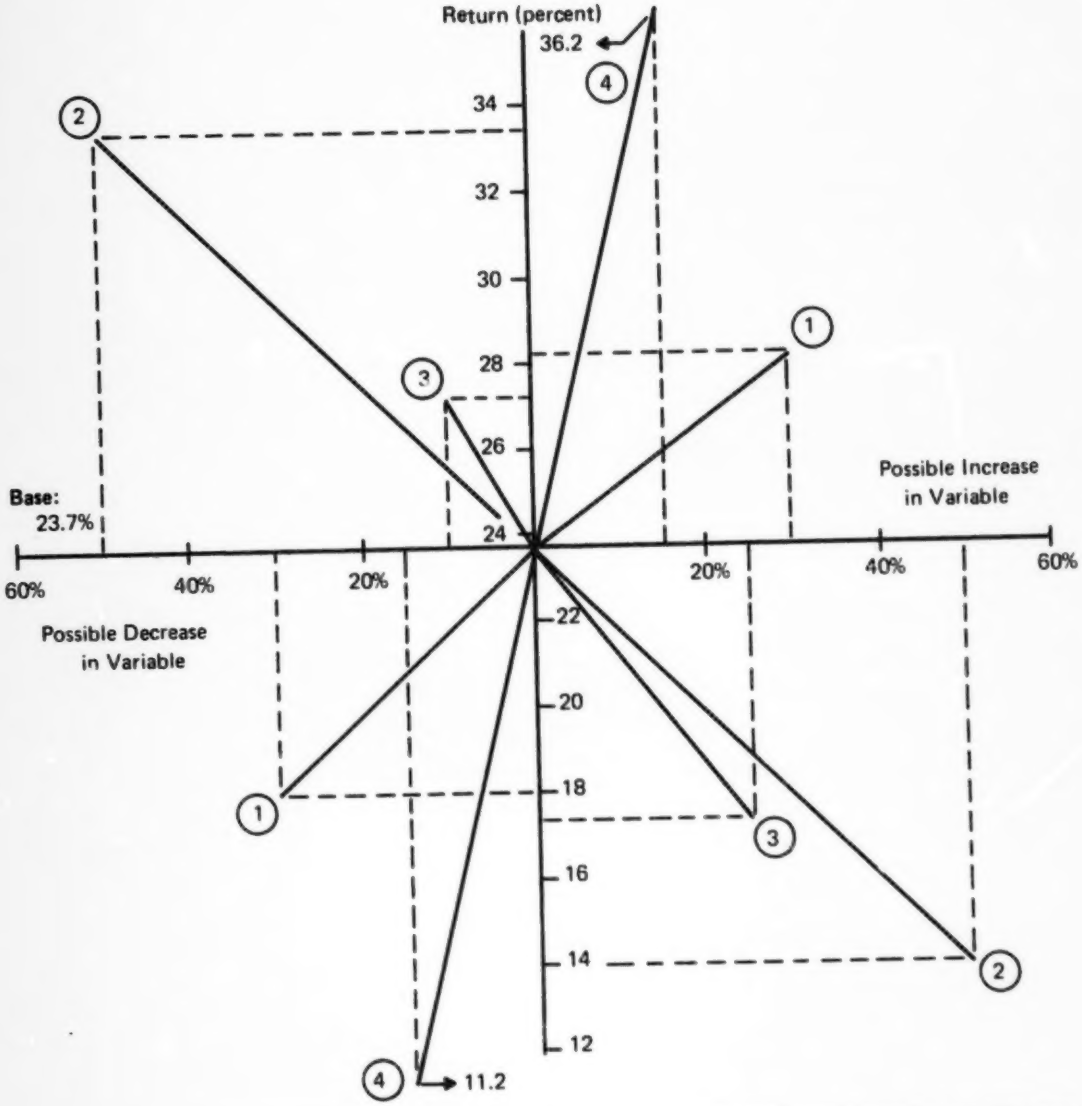

KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+30, −30	300	390	210
2. Delivered Cost of Fiber, $/ADMT	+50, −50	45	68	23
3. Fixed Capital, $ Million	+25, −10	28	35	25
4. Selling Price, $/MDMT	+15, −15	230	265	195

FIGURE IX–L–19 SENSITIVITY OF THE PRE-TAX RETURN ON FIXED CAPITAL OF GROUNDWOOD MARKET PULP (SECONDARY NEWSPRINT) TO KEY VARIABLES

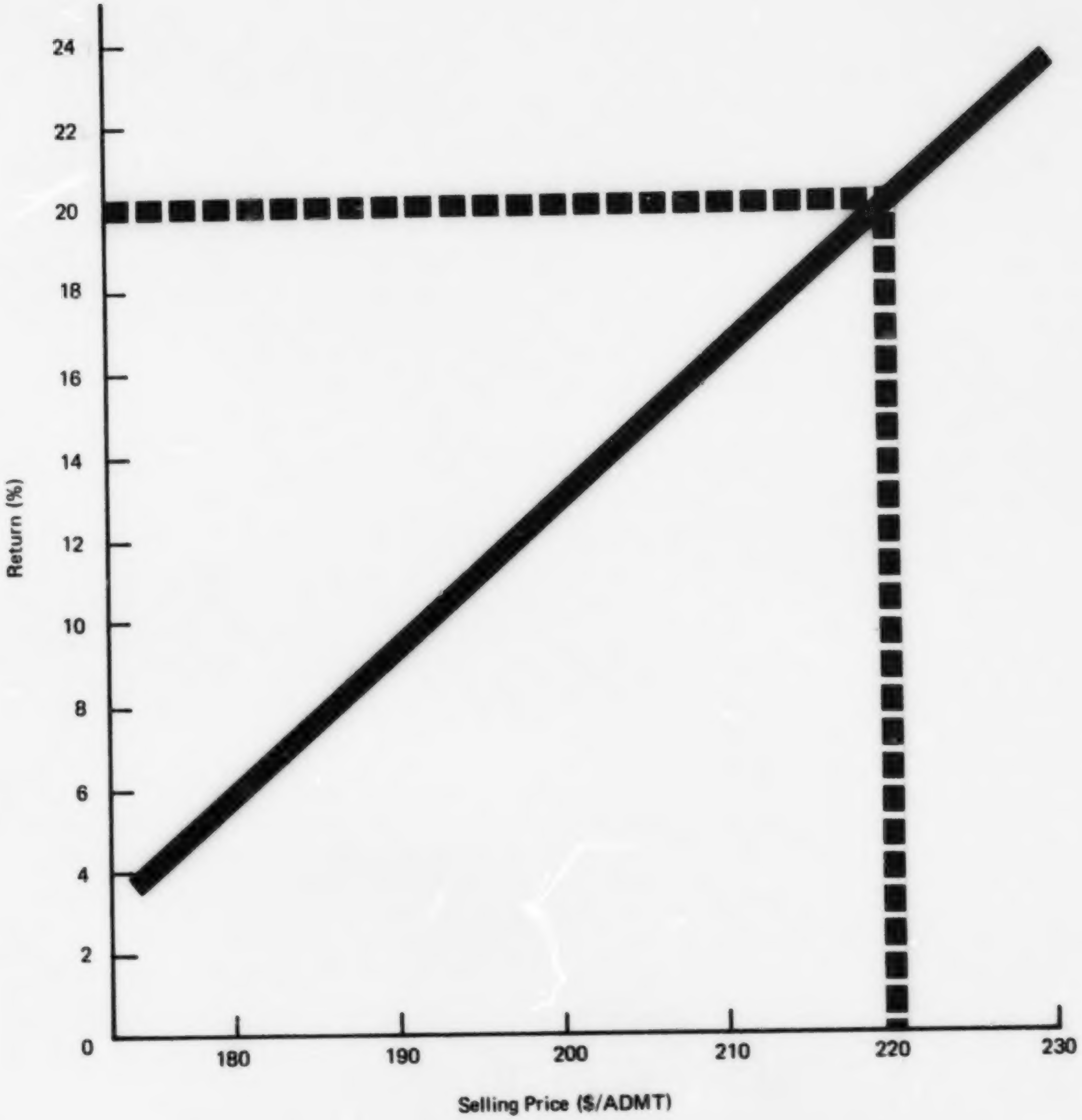

FIGURE IX–L–20 PRE-TAX RETURN ON FIXED CAPITAL VERSUS SELLING PRICE FOR GROUNDWOOD MARKET PULP (Secondary Newsprint)

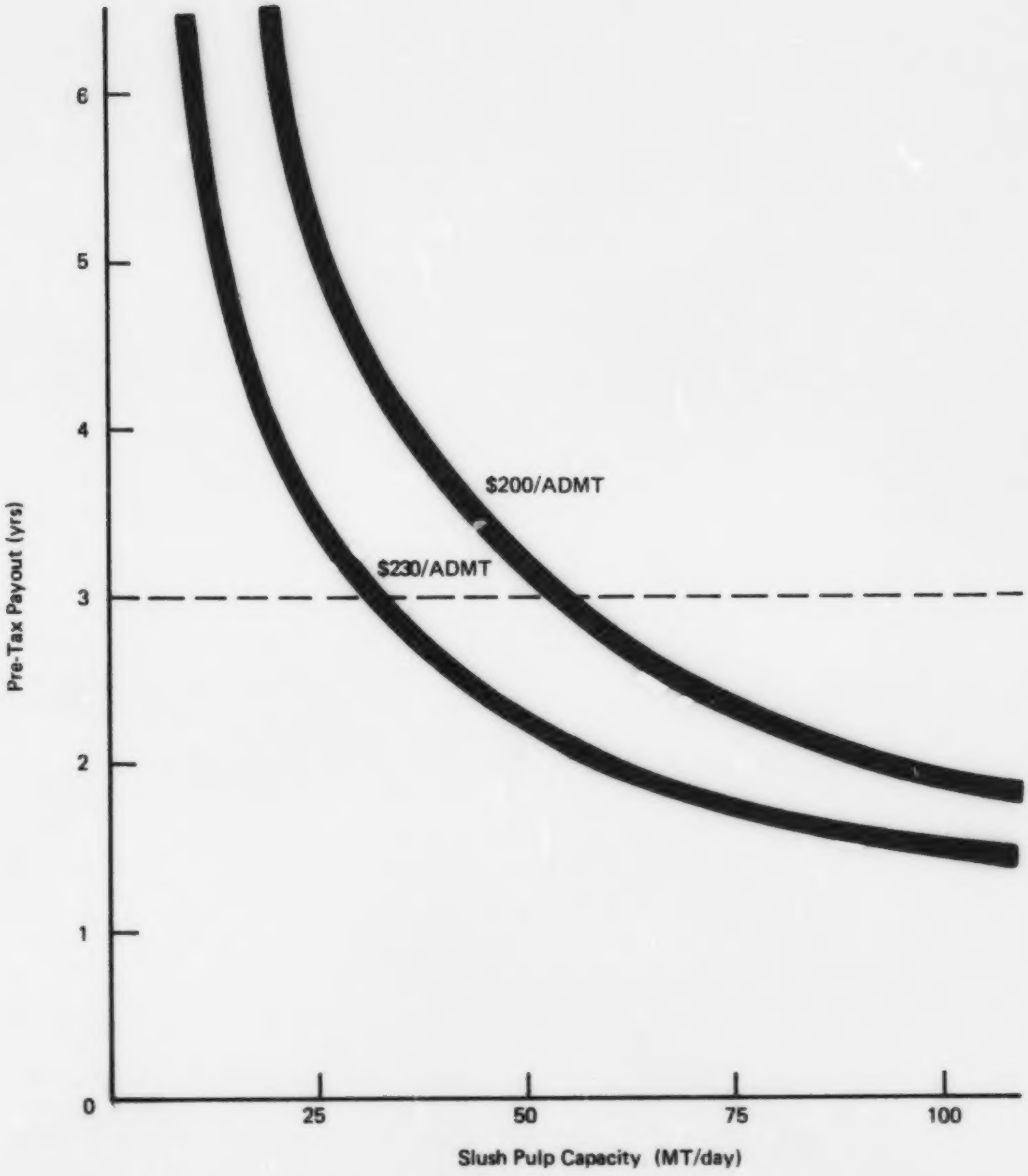

FIGURE IX–L–21 SLUSH PULP FROM SECONDARY NEWSPRINT DE-INKING – PLANT PAYOUT VERSUS CAPACITY AT VARIOUS SELLING PRICES FOR COMPETITIVE MARKET PULP

M. SLUSH PULP (VIRGIN)

We have presented six cost models for slush pulp: bleached softwood and hardwood kraft in the Northeast and Southeast, unbleached softwood kraft in the Southeast, and groundwood in the Northeast. These slush pulp models form the basis of the fiber raw material costs for all paper and board models integrated to these grades. The definition of slush pulp and the allocation of costs between slush pulp production and on-site pulp drying, papermaking, or board production are detailed in Section A.6.

Since slush pulp is a raw material cost in paper or board production, the effect of any variable such as wood cost, scale of pulping operations, or pulp mill location must first be evaluated in terms of the net change in slush pulp manufacturing cost; this is done by using the sensitivity charts for each slush pulp model. The change in slush pulp cost, expressed as a percentage increase or decrease from the base-level cost, can then be entered in the sensitivity charts for the various integrated paper and board grades as a percentage change in delivered cost of fiber to determine the net effect on delivered cost or return on capital.

Variations in energy cost will affect both slush pulp and papermaking costs. In this instance, the combined effect must be measured. This is done by first calculating the change in the cost of slush pulp and then calculating the combined effect on papermaking cost of the change in slush pulp cost plus the direct effect of the change in energy cost. This is particularly significant in newsprint and groundwood paper production, since groundwood slush pulp is highly dependent on purchased power.

TABLE IX-M-1

ECONOMIC SUMMARY OF BLEACHED KRAFT SLUSH PULP MANUFACTURE

Functional Group	N.A.			
Grade	Softwood		Hardwood	
Basis Weight	N.A.			
Fiber Furnish	100% Virgin			
Plant Size, ADMT/day	730			
Plant Location	Southeast	Northeast	Southeast	Northeast
Plant Specifics	Integrated			
Total Fixed Capital ($Million)	113	113	105	105
" " " per daily ton ($000)	154.8	154.8	143.8	143.8
Total Factory Cost	136.0	173.2	118.5	136.7
Raw Materials (delivered)($/MT)	72.5	107.3	57.7	72.5
Conversion ($/MT)	29.1	31.5	27.7	31.1
Capital-Related ($/MT)	34.4	34.4	33.1	33.1
Sales Cost (less freight)($/MT)	N.A.			
Freight in ($MT/product)*	16.9	21.2	14.9	14.9
Freight out ($/MT product)	N.A.			
Selling Price	N.A.			
Return on Fixed Capital, pre-tax	N.A.			

*Not included in total delivered cost

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TABLE IX-M-2

DESIGN BASIS

Functional Group	General	Process	Continuous kraft pulping, C-E-D-E-D bleaching
Grade	Bl. kraft softwood slush pulp	Fiber Furnish	100% virgin fiber; softwood from 50% roundwood & 50% chips
Basis Weight	n.a.	Pulp Yield	42%
Production	730 ADMT/day; 252,000 ADMT/yr	Mill Location	Southeast
Net Operating Days	345/yr	Boundary Limits	Wood preparation through bleached pulp Production

CAPITAL REQUIREMENTS* ($000)

Physical Plant	103,100	
Other Fixed Capital	10,300	
Total Fixed Capital		113,000
Working Capital		9,000
Total Capital Required		122,000

ENERGY REQUIREMENTS (per ADMT)

	Steam (kg)	Power (kWh)
Wood Preparation	–	120
Pulping	1,970	130
Bleaching	3,620	100
Power & Steam Gen. (incl. recovery & liquor prep.)	1,970	200
Effluent Treatment	–	40
Misc. & Auxiliaries	1,480	30
Total	9,040	620

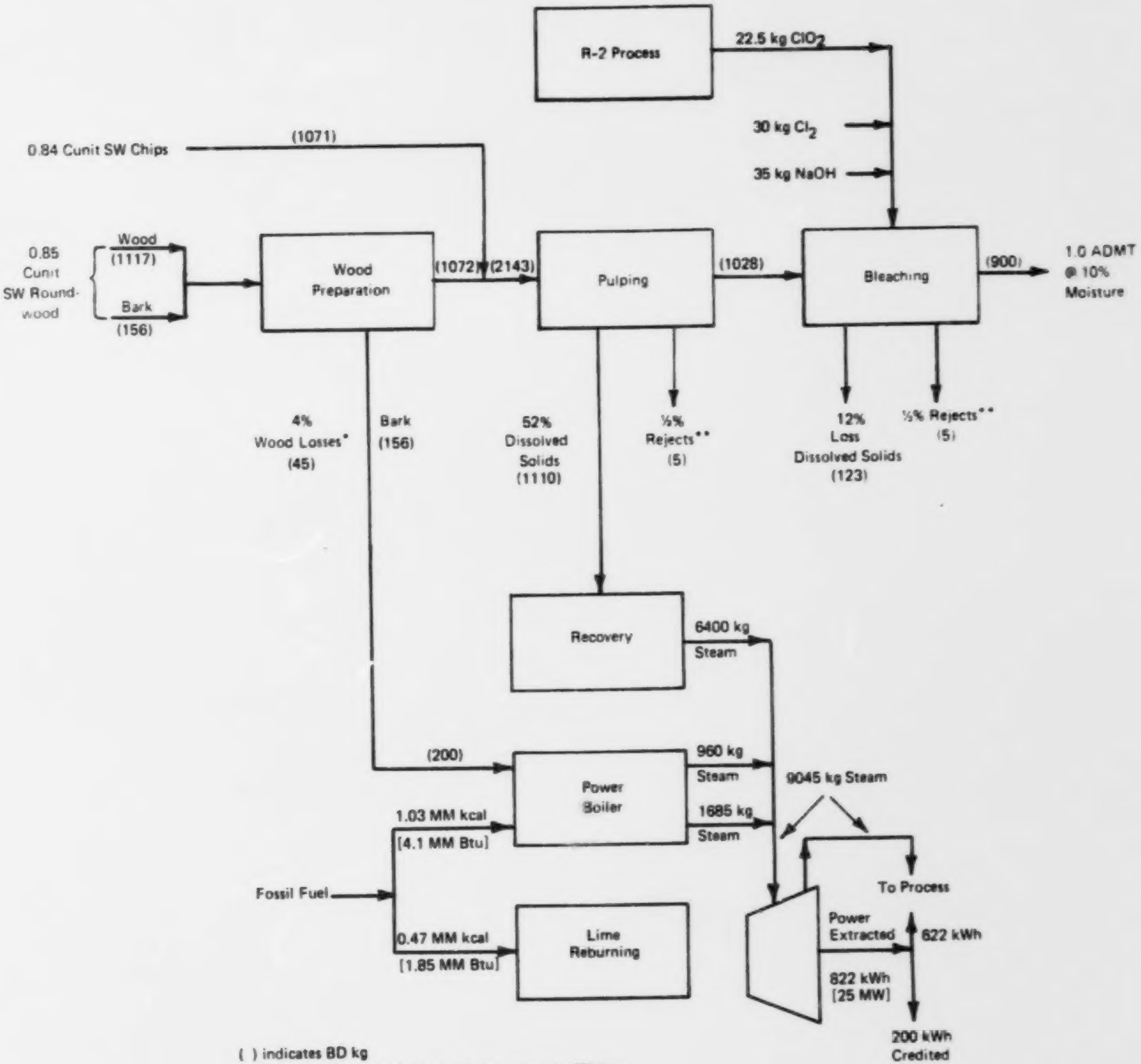
OPERATING COST* ($/ADMT)

Fiber Furnish	54.1	
Other Raw Materials	18.4	
Total Raw Materials Cost		72.5
Labor + Fringe @ 32% of Hourly Rate	14.1	
Supplies	7.9	
Energy	3.6	
Factory Overhead	3.6	
Total Conversion Costs		29.1
Capital-Related Costs		34.4
• Total Factory Operating Cost		136.0 ($123.4/ADST)
GS&A		
Freight Out		
Total Cost of Sales		n.a.
• Total Delivered Cost		n.a.

*Totals may not add due to rounding.

FIGURE IX-M-1

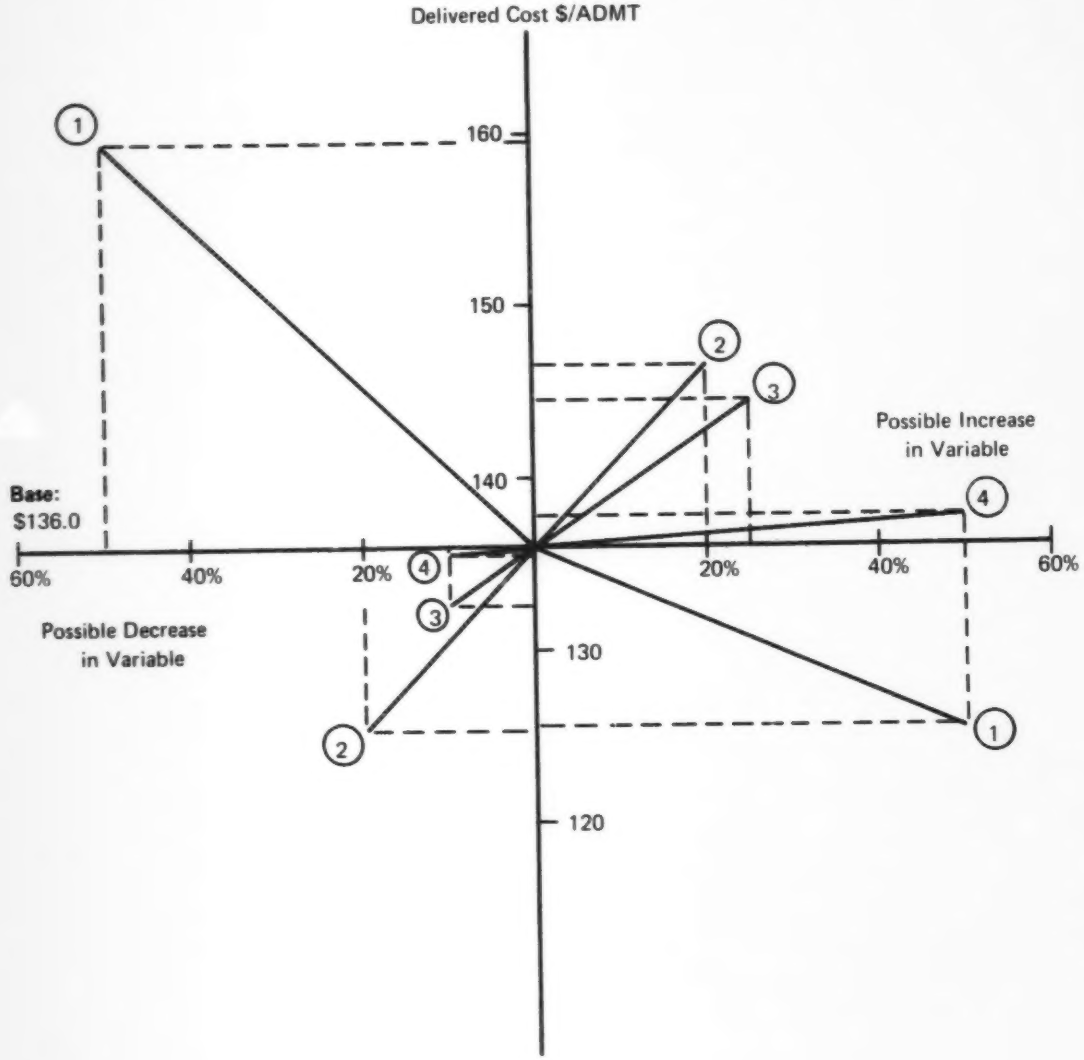
MATERIAL AND ENERGY BALANCE
(Basis: 1 ADMT slush pulp)


R-2 Process
22.5 kg ClO2
30 kg Cl2
35 kg NaOH
0.84 Cunit SW Chips
(1071)
0.85 Cunit SW Round-wood
Wood
(1117)
Bark
(156)
Wood Preparation
(1072)
(2143)
Pulping
(1028)
Bleaching
(900)
1.0 ADMT @ 10% Moisture
4% Wood Losses* (45)
Bark (156)
52% Dissolved Solids (1110)
½% Rejects** (5)
12% Loss Dissolved Solids (123)
½% Rejects** (5)
Recovery
6400 kg Steam
(200)
Power Boiler
960 kg Steam
1685 kg Steam
9045 kg Steam
1.03 MM kcal
[4.1 MM Btu]
Fossil Fuel
0.47 MM kcal
[1.85 MM Btu]
Lime Reburning
To Process
Power Extracted
622 kWh
822 kWh
[25 MW]
200 kWh Credited

( ) indicates BD kg

*2% loss on barking (suitable for fuel recovery) + 2% loss on chipping suitable for fuel or fiber recover)

**Fiber loss (suitable for recovery in lower-grade products)



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+50, −50	730	1100	365
2. Delivered Cost of Fiber, $/Cunit	+20, −20	32	38	26
3. Fixed Capital, $ Million	+25, −10	113	102	141
4. Cost of Energy, $/MMBtu	+50, −10	1.0	1.5	0.9

FIGURE IX–M–2 SENSITIVITY OF THE MANUFACTURING COST OF BLEACHED SOFTWOOD KRAFT SLUSH PULP (SOUTHEAST) TO KEY VARIABLES

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TABLE IX-M-4

DESIGN BASIS

Functional Group	General	Process	Continuous kraft pulping, C-E-D-E-D bleaching
Grade	Bl. kraft softwood slush pulp	Fiber Furnish	100% virgin fiber; softwood from 50% roundwood & 50% chips
Basis Weight	n.a.	Pulp Yield	42%
Production	730 ADMT/day; 252,000 ADMT/yr	Mill Location	Northeast
Net Operating Days	345/yr	Boundary Limits	Wood preparation through bleached pulp Production

CAPITAL REQUIREMENTS* ($000)

Physical Plant	103,100	
Other Fixed Capital	10,300	
Total Fixed Capital		113,000
Working Capital		11,000
Total Capital Required		124,000

ENERGY REQUIREMENTS (per ADMT)

	Steam (kg)	Power (kWh)
Wood Preparation	–	120
Pulping	1,970	130
Bleaching	3,620	100
Power & Steam Gen. (incl. recovery & liquor prep.)	1,970	200
Effluent Treatment	–	40
Misc. & Auxiliaries	1,480	30
Total	9,040	620

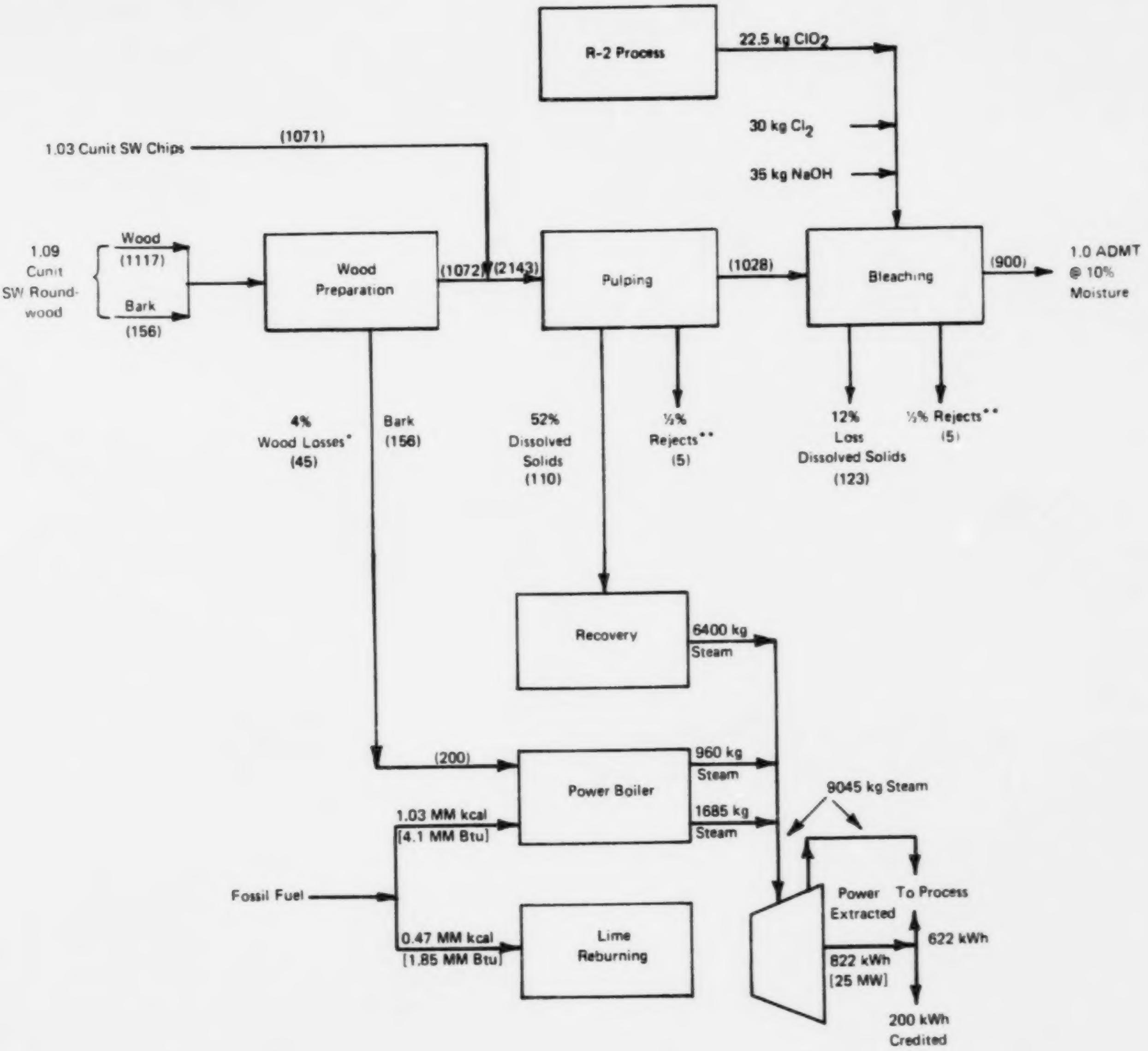
OPERATING COST* ($/ADMT)

Fiber Furnish	86.9	
Other Raw Materials	20.4	
Total Raw Materials Cost		107.3
Labor + Fringe @ 32% of Hourly Rate	12.4	
Supplies	7.9	
Energy	7.7	
Factory Overhead	3.6	
Total Conversion Costs		31.5
Capital-Related Costs		34.4
● Total Factory Operating Cost		173.2 ($157.1/ ADST)
GS&A		
Freight Out		
Total Cost of Sales		n.a.
● Total Delivered Cost		n.a.

*Totals may not add due to rounding.

FIGURE IX-M-3

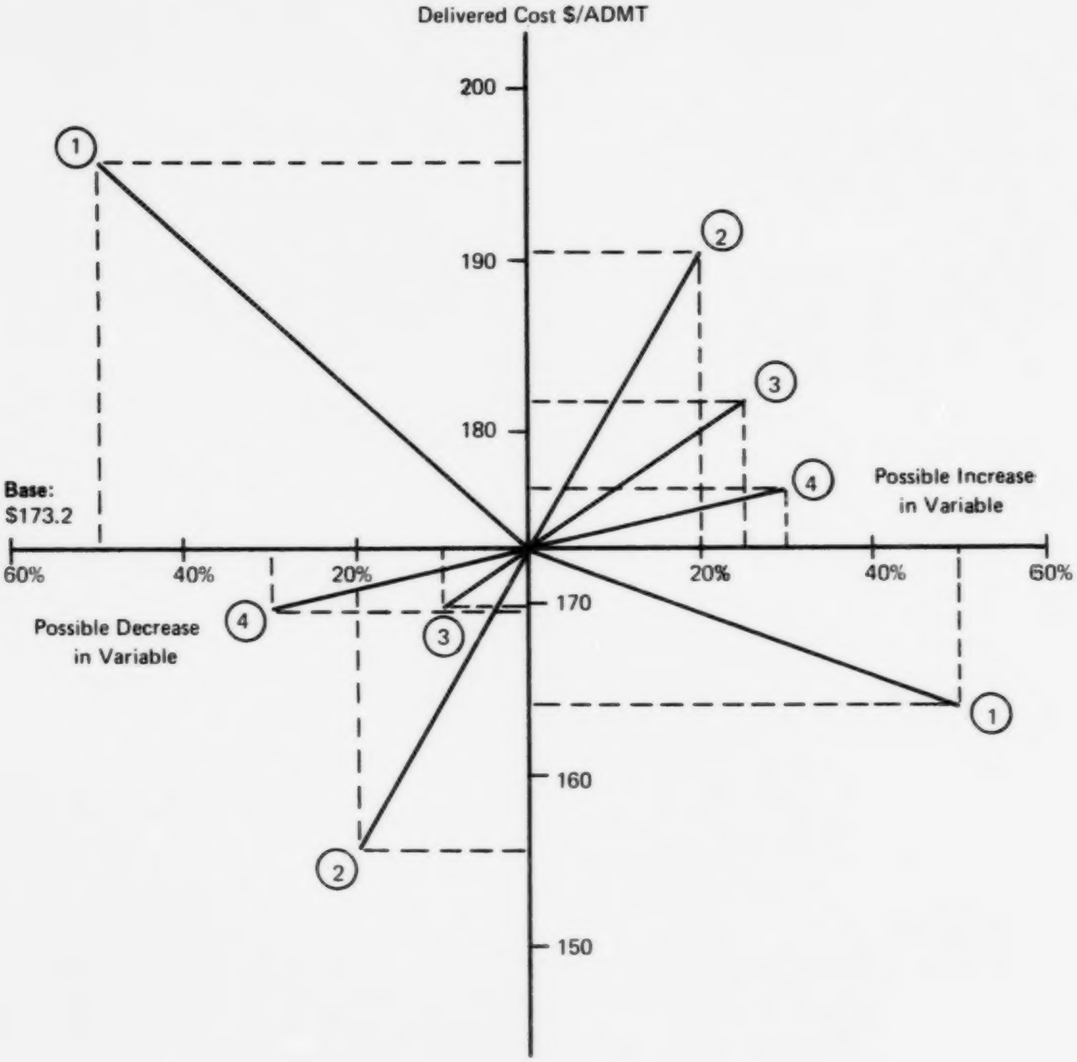
MATERIAL AND ENERGY BALANCE
(Basis: 1 ADMT slush pulp)


R-2 Process
22.5 kg ClO_2
30 kg Cl_2
35 kg NaOH
1.03 Cunit SW Chips
(1071)
1.09 Cunit SW Round-wood
Wood
(1117)
Bark
(156)
Wood Preparation
(1072)
(2143)
Pulping
(1028)
Bleaching
(900)
1.0 ADMT @ 10% Moisture
4% Wood Losses*
(45)
Bark
(156)
52% Dissolved Solids
(110)
½% Rejects**
(5)
12% Loss Dissolved Solids
(123)
½% Rejects**
(5)
Recovery
6400 kg Steam
(200)
Power Boiler
960 kg Steam
1685 kg Steam
9045 kg Steam
1.03 MM kcal
[4.1 MM Btu]
Fossil Fuel
0.47 MM kcal
[1.85 MM Btu]
Lime Reburning
Power Extracted
To Process
822 kWh
[25 MW]
622 kWh
200 kWh Credited

( ) Indicates BD kg

* 2% loss on barking (suitable for fuel recovery) + 2% loss on chipping (suitable for fuel or fiber recovery)

** Fiber loss (suitable for recovery in lower-grade products)



KEY VARIABLES		Percent Variation	Best Guess	Possible High	Possible Low
1.	Scale of Operations, MTPD	+50, −50	730	1100	365
2.	Delivered Cost of Fiber, $/Cunit	+20, −20	41	49	33
3.	Fixed Capital, $ Million	+25, −10	113	141	102
4.	Cost of Energy, $/MMBtu	+30, −30	2.0	2.6	1.4

FIGURE IX–M–4 SENSITIVITY OF THE MANUFACTURING COST OF BLEACHED SOFTWOOD KRAFT SLUSH PULP (NORTHEAST) TO KEY VARIABLES

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TABLE IX-M-6

DESIGN BASIS

Functional Group	General	Process	Continuous kraft pulping; C-E-D-E-D bleaching
Grade	Bl. hardwood kraft slush pulp	Fiber Furnish	100% virgin fiber; hardwood from 50/50 roundwood/chips
Basis Weight	n.a.	Pulp Yield	Bleached – 44%
Production	730 ADMT/day; 252,000 ADMT/yr	Mill Location	Southeast
Net Operating Days	345/yr	Boundary Limits	Wood preparation through bleached pulp

CAPITAL REQUIREMENTS* ($000)

Physical Plant	95,700	
Other Fixed Capital	9,600	
Total Fixed Capital		105,000
Working Capital		8,000
Total Capital Required		113,000

ENERGY REQUIREMENTS (per ADMT)

	Steam (kg)	Power (kWh)
Wood Preparation	–	110
Pulping	1,810	115
Bleaching	3,290	95
Power & Steam Gen. (incl. recovery & liquor prep.)	1,810	180
Effluent Treatment	–	20
Misc. & Auxiliaries	1,350	45
Total	8,260	565

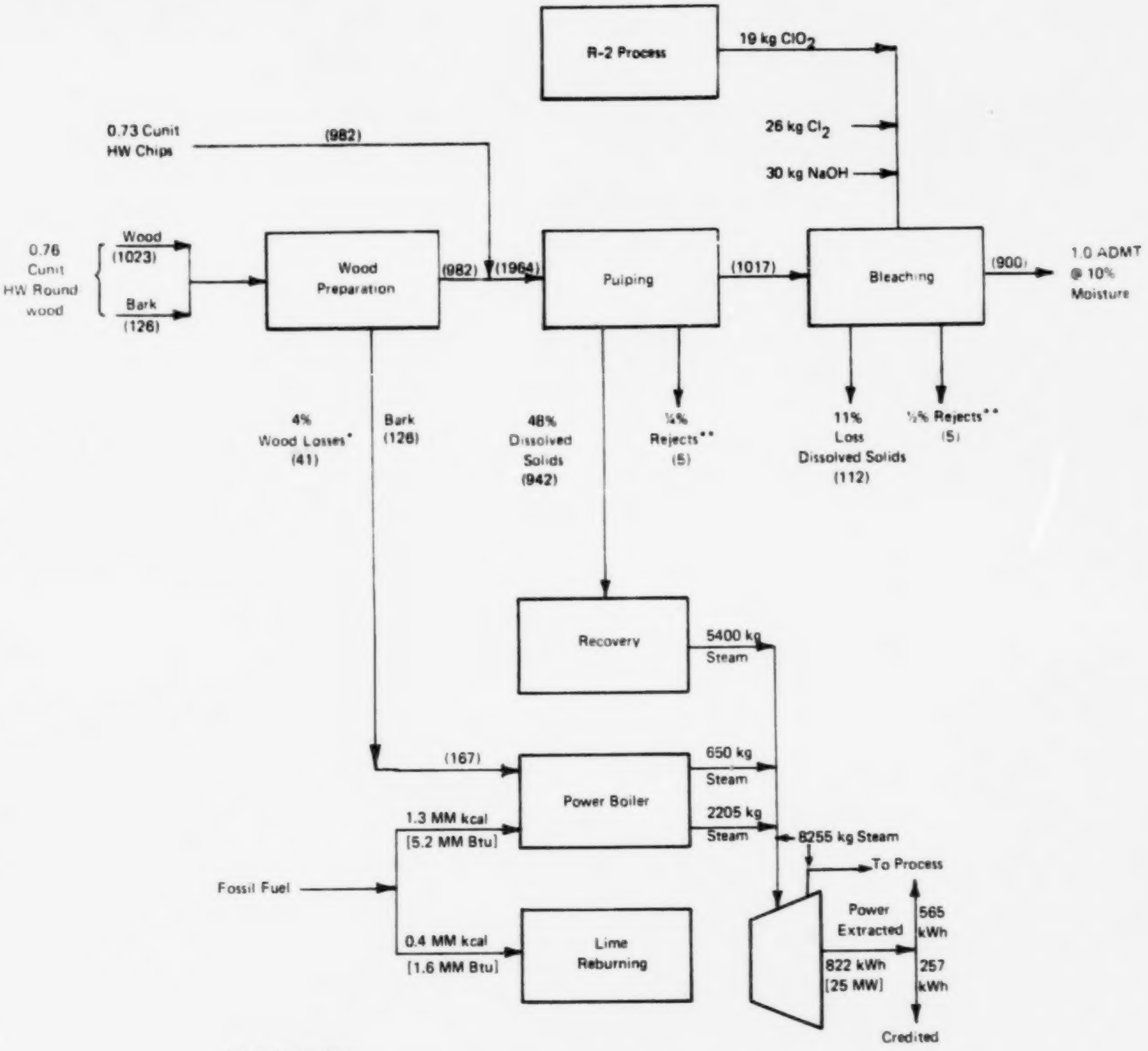
OPERATING COST* ($/ADMT)

Fiber Furnish	40.2	
Other Raw Materials	17.4	
Total Raw Materials Cost		57.7
Labor + Fringe @ 32% of Hourly Rate	12.7	
Supplies	7.9	
Energy	3.8	
Factory Overhead	3.5	
Total Conversion Costs		27.7
Capital-Related Costs		33.1
● Total Factory Operating Cost		118.5 ($107.5/ ADST)
GS&A		
Freight Out		
Total Cost of Sales		n.a.
● Total Delivered Cost		n.a.

*Totals may not add due to rounding.

FIGURE IX-M-5

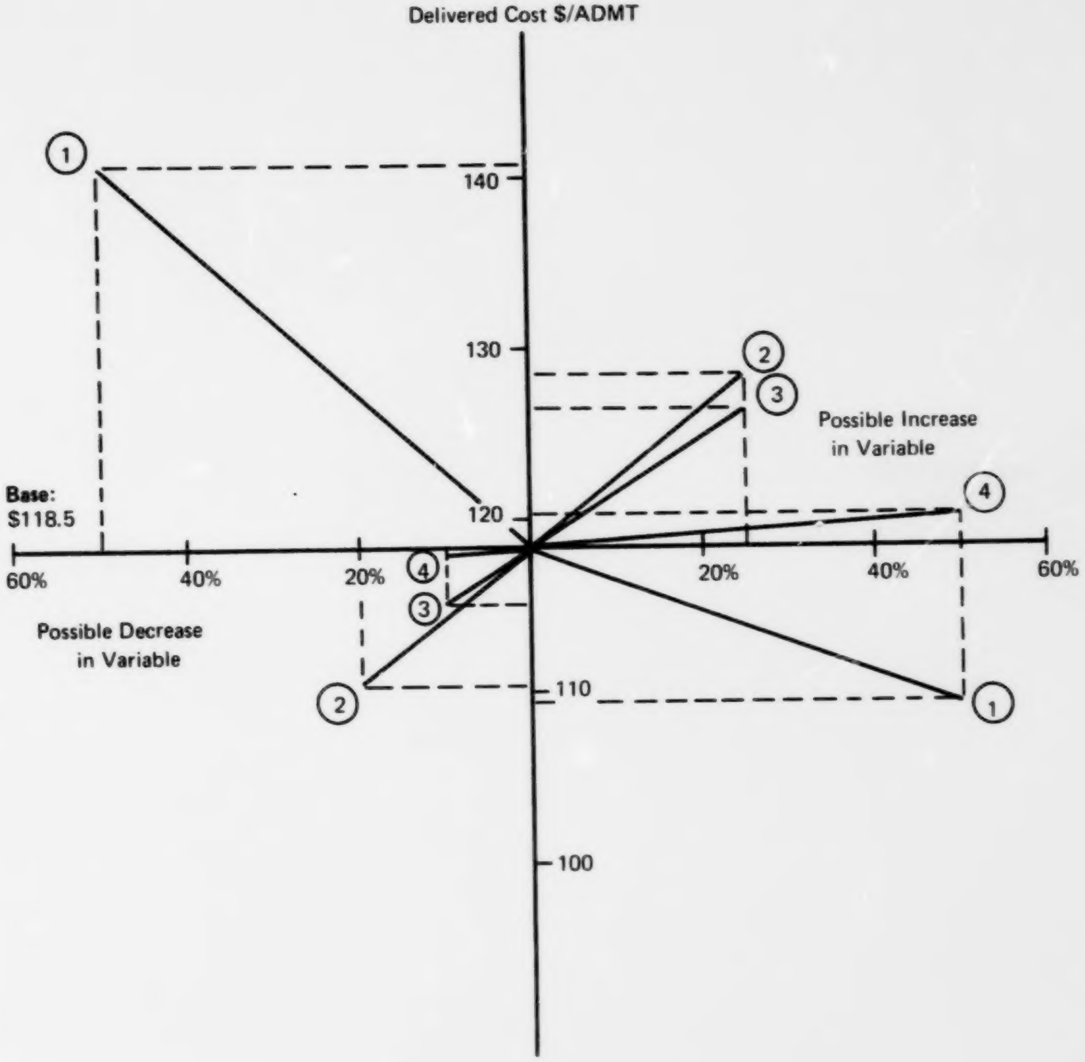
MATERIAL AND ENERGY BALANCE
(Basis: 1 ADMT slush pulp)


R-2 Process
19 kg ClO$_2$
26 kg Cl$_2$
30 kg NaOH
0.73 Cunit
HW Chips
(982)
0.76
Cunit
HW Round
wood
Wood
(1023)
Bark
(126)
Wood
Preparation
(982)
(1964)
Pulping
(1017)
Bleaching
(900)
1.0 ADMT
@ 10%
Moisture
4%
Wood Losses*
(41)
Bark
(126)
48%
Dissolved
Solids
(942)
¼%
Rejects**
(5)
11%
Loss
Dissolved Solids
(112)
½% Rejects**
(5)
Recovery
5400 kg
Steam
(167)
Power Boiler
650 kg
Steam
2205 kg
Steam
8255 kg Steam
To Process
1.3 MM kcal
[5.2 MM Btu]
Fossil Fuel
0.4 MM kcal
[1.6 MM Btu]
Lime
Reburning
Power
Extracted
822 kWh
[25 MW]
565
kWh
257
kWh
Credited

( ) Indicates BD kg

* 2% loss on barking (suitable for fuel recovery) + 2% loss on chipping (suitable for fuel or fiber recovery)

** Fiber loss suitable for recovery in lower-grade products



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+50, −50	730	1100	365
2. Delivered Cost of Fiber, $/Cunit	+20, −20	27	32	22
3. Fixed Capital, $ Million	+25, −10	105	131	95
4. Cost of Energy, $/MMBtu	+50, −10	1.0	1.5	0.9

FIGURE IX–M–6 SENSITIVITY OF THE MANUFACTURING COST OF BLEACHED HARDWOOD KRAFT SLUSH PULP (SOUTHEAST) TO KEY VARIABLES

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TABLE IX-M-8

DESIGN BASIS

Functional Group	General	Process	Continuous kraft pulping; C-E-D-E-D bleaching
Grade	Bl kraft hardwood slush pulp	Fiber Furnish	100% virgin fiber; hardwood from 50/50 roundwood/chips
Basis Weight	n.a.	Pulp Yield	Bleached – 44%
Production	730 ADMT/day; 252,000 ADMT/yr	Mill Location	Northeast
Net Operating Days	345/yr	Boundary Limits	Wood preparation through bleached pulp

CAPITAL REQUIREMENTS*
($000)

Physical Plant	95,700	
Other Fixed Capital	9,600	
Total Fixed Capital		105,000
Working Capital		9,000
Total Capital Required		114,000

ENERGY REQUIREMENTS
(per ADMT)

	Steam (kg)	Power (kWh)
Wood Preparation	–	110
Pulping	1,810	115
Bleaching	3,290	95
Power & Steam Gen. (incl. recovery & liquor prep.)	1,810	180
Effluent Treatment	–	20
Misc. & Auxiliaries	1,350	45
Total	8,260	565

OPERATING COST*
($/ADMT)

Fiber Furnish	55.1	
Other Raw Materials	17.4	
Total Raw Materials Cost		72.5
Labor + Fringe @ 32% of Hourly Rate	12.0	
Supplies	7.9	
Energy	8.2	
Factory Overhead	3.0	
Total Conversion Costs		31.1
Capital-Related Costs		33.1
• Total Factory Operating Cost		136.7 ($124.0/ADST)
GS&A		
Freight Out		
Total Cost of Sales		n.a.
• Total Delivered Cost		n.a.

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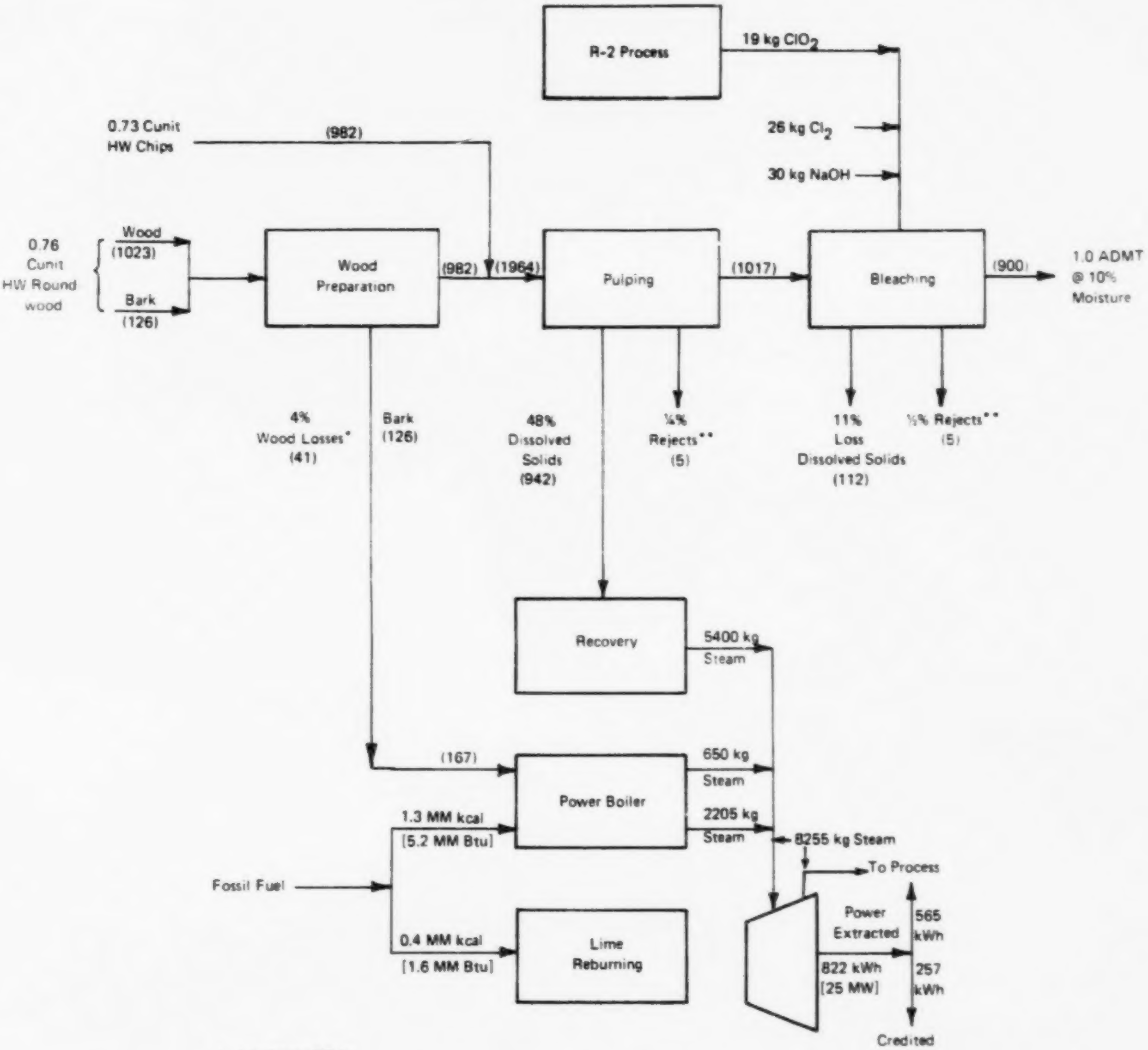
*Totals may not add due to rounding.

FIGURE IX-M-7

MATERIAL AND ENERGY BALANCE

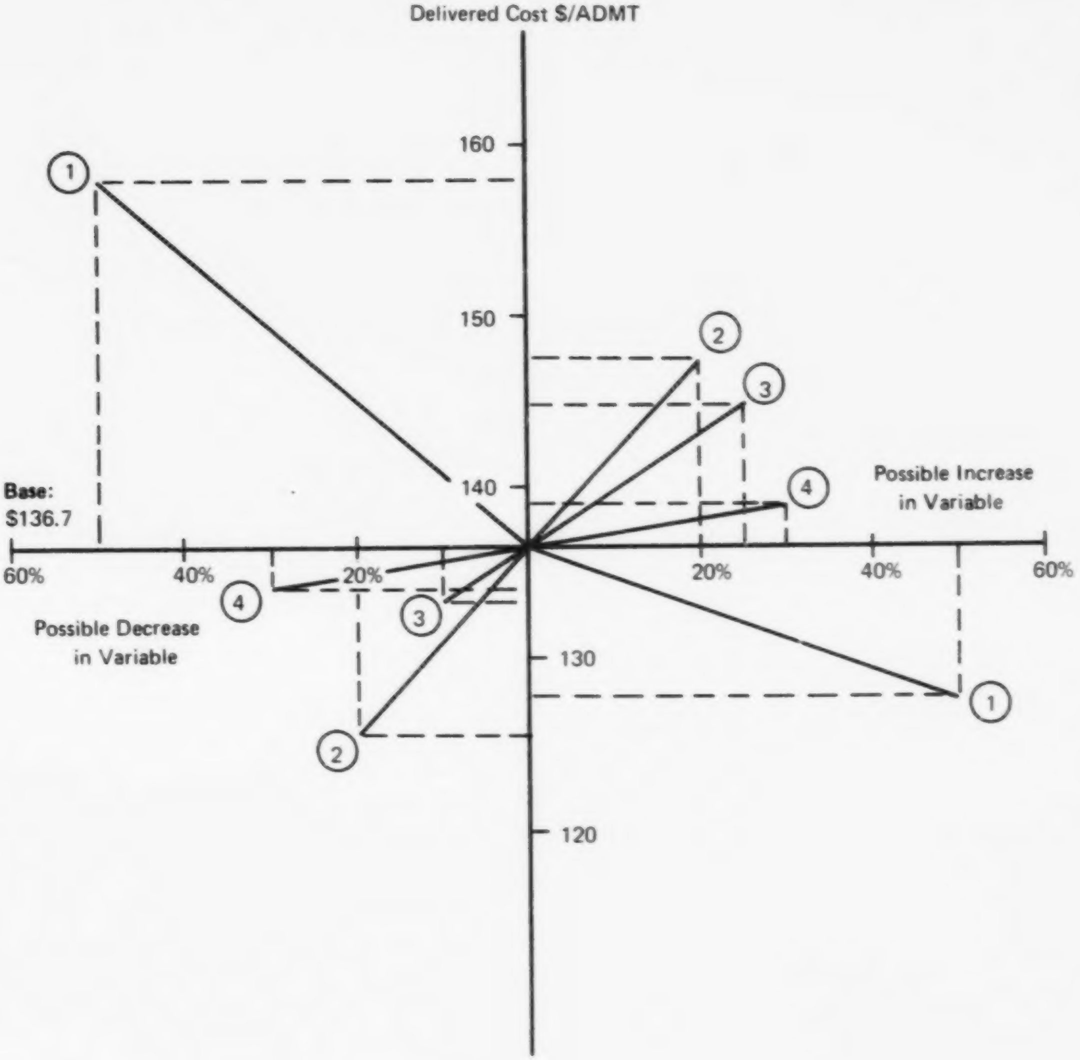
(Basis: 1 ADMT slush pulp)


R-2 Process
19 kg ClO_2
26 kg Cl_2
30 kg NaOH
0.73 Cunit
HW Chips
(982)
0.76
Cunit
HW Round
wood
Wood
(1023)
Bark
(126)
Wood
Preparation
(982)
(1964)
Pulping
(1017)
Bleaching
(900)
1.0 ADMT
@ 10%
Moisture
4%
Wood Losses*
(41)
Bark
(126)
48%
Dissolved
Solids
(942)
¼%
Rejects**
(5)
11%
Loss
Dissolved Solids
(112)
½% Rejects**
(5)
Recovery
5400 kg
Steam
(167)
Power Boiler
650 kg
Steam
2205 kg
Steam
8255 kg Steam
To Process
1.3 MM kcal
[5.2 MM Btu]
Fossil Fuel
0.4 MM kcal
[1.6 MM Btu]
Lime
Reburning
Power
Extracted
822 kWh
[25 MW]
565
kWh
257
kWh
Credited

( ) Indicates BD kg

* 2% loss on barking (suitable for fuel recovery) + 2% loss on chipping (suitable for fuel or fiber recovery)

** Fiber loss suitable for recovery in lower-grade products



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+50, −50	730	1100	365
2. Delivered Cost of Fiber, $/Cunit	+20, −20	37	44	30
3. Fixed Capital, $ Million	+25, −10	105	131	95
4. Cost of Energy, $/MMBtu	+30, −30	2.0	2.6	1.4

FIGURE IX–M–8 SENSITIVITY OF THE MANUFACTURING COST OF BLEACHED HARDWOOD KRAFT SLUSH PULP (NORTHEAST) TO KEY VARIABLES

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TABLE IX-M-10

ECONOMIC SUMMARY OF SLUSH PULP MANUFACTURE

Functional Group	N.A.	
Grade	Unbl. SW Kraft	Groundwood
Basis Weight	N.A.	
Fiber Furnish	100% Virgin	
Plant Size, ADMT/day	730	400
Plant Location	Southeast	Northeast
Plant Specifics	Integrated	
Total Fixed Capital ($Million)	84	22
" " " per daily ton ($000)	115.0	55.0
Total Factory Cost	91.3	85.1
Raw Materials (delivered)($/MT)	46.4	39.7
Conversion ($/MT)	19.4	32.9
Capital Related ($/MT)	25.6	12.4
Sales Cost (less freight)($MT)	N.A.	
Freight in ($/MT product)*	14.5	9.2
Freight out ($/MT product)	N.A.	
Selling Price	N.A.	
Return on Fixed Capital, pre-tax	N.A.	

*Not included in total delivered cost

TABLE IX-M-11

DESIGN BASIS

Functional Group	General	Process	Continuous kraft pulping
Grade	Unbl. SW kraft slush pulp	Fiber Furnish	100% virgin SW fiber from 50/50 roundwood/chips
Basis Weight	n.a.	Pulp Yield	48%
Production	730 ADMT/day; 252,000 ADMT/yr	Mill Location	Southeast
Net Operating Days	345/yr	Boundary Limits	Wood preparation through pulping

CAPITAL REQUIREMENTS* ($000)

Physical Plant	76,400	
Other Fixed Capital	7,700	
Total Fixed Capital		84,000
Working Capital		6,000
Total Capital Required		90,000

ENERGY REQUIREMENTS (per ADMT)

	Steam (kg)	Power (kWh)
Wood Preparation	–	107
Digester (incl. washing & screening)	1,734	111
Power/Steam Gen. (incl. recovery & liquor prep.)	1,734	173
Effluent Treatment	–	20
Water Supply	–	20
Misc. & Auxiliaries	867	19
Total	4,335	450

OPERATING COST* ($/ADMT)

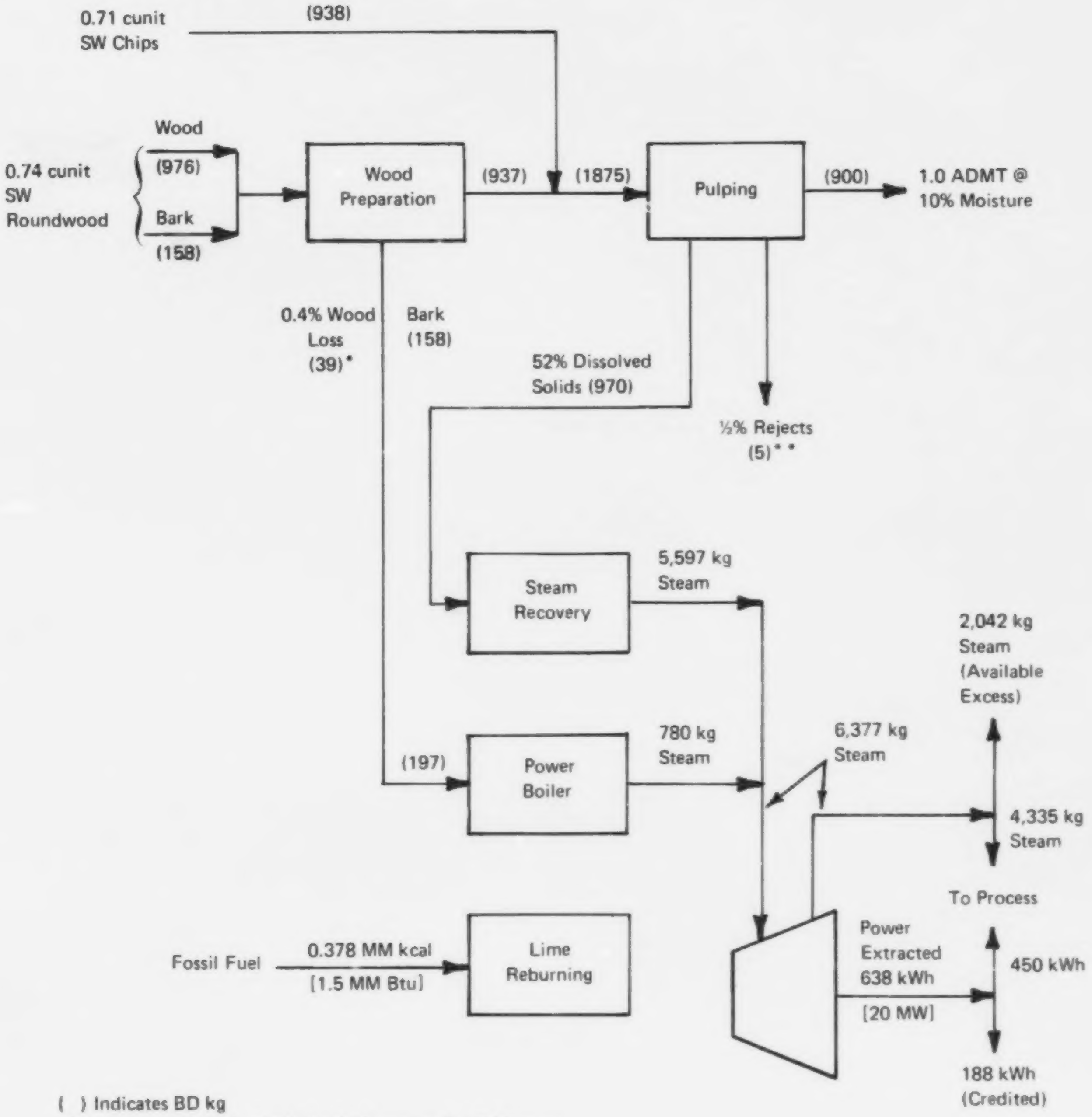
Fiber Furnish	46.4	
Other Raw Materials	0	
Total Raw Materials Cost		46. 4
Labor + Fringe @ 32% of Hourly Rate	10.2	
Supplies	6.4	
Energy	(0.8)	
Factory Overhead	3.4	
Total Conversion Costs		19.4
Capital-Related Costs		25.6
● Total Factory Operating Cost		91.3 $100.6/ADST)
GS&A		Not applicable
Freight Out		–
Total Cost of Sales		–
● Total Delivered Cost		

*Totals may not add due to rounding.

FIGURE IX-M-9

MATERIAL AND ENERGY BALANCE

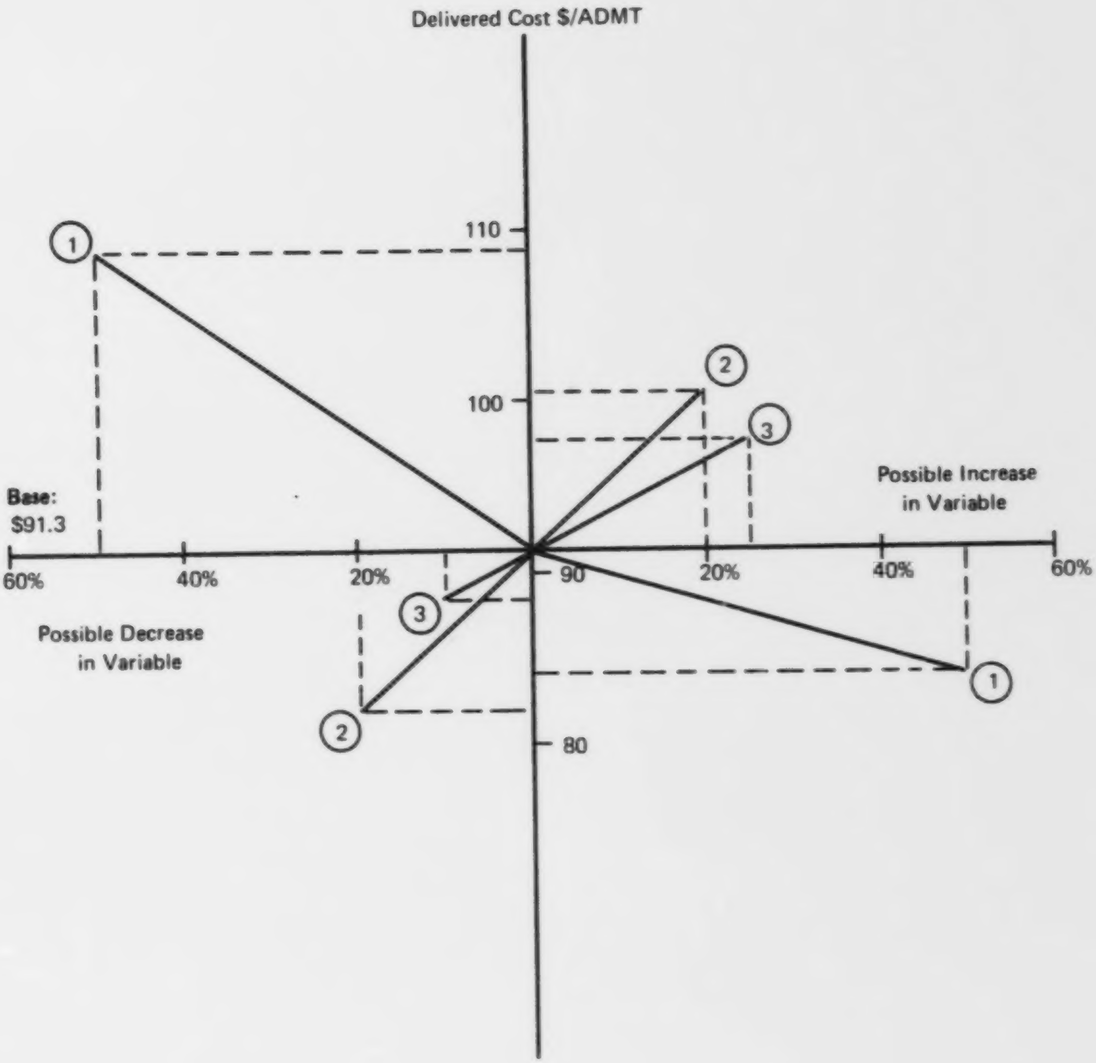
(Basis: 1.0 ADMT slush pulp)


0.71 cunit
SW Chips
(938)
Wood
0.74 cunit
SW
Roundwood
(976)
Bark
(158)
Wood
Preparation
(937)
(1875)
Pulping
(900)
1.0 ADMT @
10% Moisture
0.4% Wood
Loss
(39)*
Bark
(158)
52% Dissolved
Solids (970)
½% Rejects
(5)**
Steam
Recovery
5,597 kg
Steam
2,042 kg
Steam
(Available
Excess)
(197)
Power
Boiler
780 kg
Steam
6,377 kg
Steam
4,335 kg
Steam
To Process
Fossil Fuel
0.378 MM kcal
[1.5 MM Btu]
Lime
Reburning
Power
Extracted
638 kWh
[20 MW]
450 kWh
188 kWh
(Credited)

( ) Indicates BD kg

*2% loss on barking (suitable for fuel recovery) + 2% loss on chipping (suitable for fiber or fuel recovery)

** Fiber loss, suitable for recovery



KEY VARIABLES		Percent Variation	Best Guess	Possible High	Possible Low
1.	Scale of Operations, MTPD	+50, −50	730	1100	365
2.	Delivered Cost of Fiber, $/Cunit	+20, −20	32	38	26
3.	Fixed Capital, $ Million	+25, −10	84	105	76
4.	Cost of Energy, $/MMBtu	(Not Applicable)			

FIGURE IX–M–10 SENSITIVITY OF THE MANUFACTURING COST OF UNBLEACHED SOFTWOOD KRAFT SLUSH PULP (SOUTHEAST) TO KEY VARIABLES

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TABLE IX-M-13

DESIGN BASIS

Functional Group	**General**	Process	Stone groundwood
Grade	Groundwood slush pulp	Fiber Furnish	100% softwood (spruce/fir)
Basis Weight	n.a.	Pulp Yield	Unbleached – 95%
Production	400 ADMT/day; 136,000 ADMT/yr	Mill Location	Northeast
Net Operating Days	340/yr	Boundary Limits	Wood preparation through pulping

CAPITAL REQUIREMENTS* ($000)

Physical Plant	20,100	
Other Fixed Capital	2,000	
Total Fixed Capital		22,000
Working Capital		3,000
Total Capital Required		25,000

ENERGY REQUIREMENTS (per ADMT)

	Steam (kg)	Power (kWh)
Wood Preparation	–	25
Pulping	–	1,350
Effluent Treatment	–	15
Misc. & Auxiliaries	140	10
Total	140	1,400

OPERATING COST* ($/ADMT)

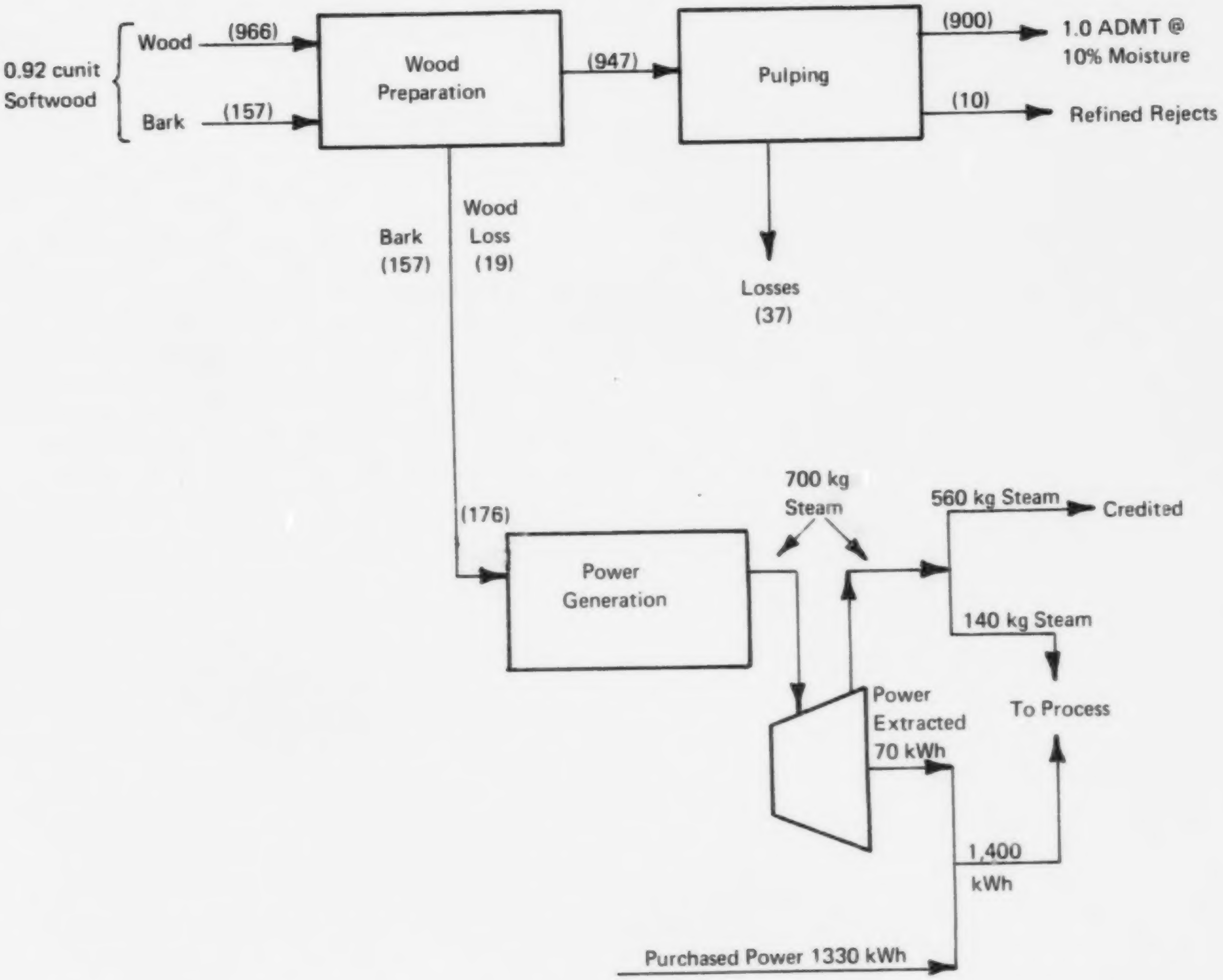
Fiber Furnish	37.7	
Other Raw Materials	2.0	
Total Raw Materials Cost		39.7
Labor + Fringe @ 32% of Hourly Rate	12.9	
Supplies	3.5	
Energy	10.8	
Factory Overhead	5.7	
Total Conversion Costs		32.9
Capital-Related Costs		12.4
• Total Factory Operating Cost		85.1 ($77.2/ADST)
GS&A		
Freight Out		
Total Cost of Sales		n.a.
• Total Delivered Cost		n.a.

*Totals may not add due to rounding.

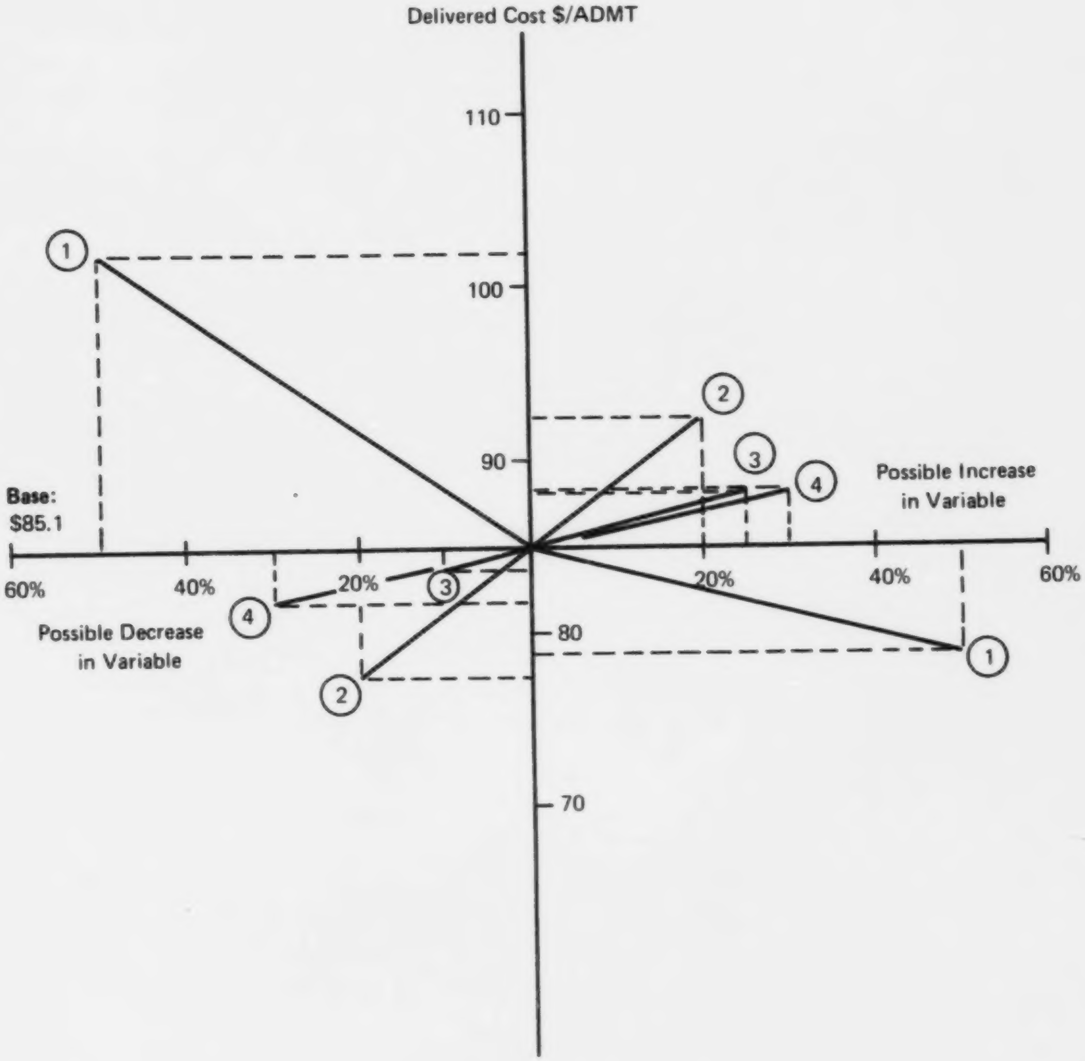
FIGURE IX-M-11

MATERIAL AND ENERGY BALANCE

(Basis: 1.0 ADMT slush pulp)


0.92 cunit Softwood
Wood
(966)
Bark
(157)
Wood Preparation
(947)
Pulping
(900)
1.0 ADMT @ 10% Moisture
(10)
Refined Rejects
Bark (157)
Wood Loss (19)
Losses (37)
(176)
Power Generation
700 kg Steam
560 kg Steam
Credited
140 kg Steam
To Process
Power Extracted 70 kWh
1,400 kWh
Purchased Power 1330 kWh

( ) Indicates BD kg



KEY VARIABLES	Percent Variation	Best Guess	Possible High	Possible Low
1. Scale of Operations, MTPD	+50, −50	400	600	200
2. Delivered Cost of Fiber, $/Cunit	+20, −20	41	49	33
3. Fixed Capital, $ Million	+25, −10	22	28	20
4. Cost of Energy, $/MMBtu	+30, −30	2.0	2.6	1.4

FIGURE IX–M–12 SENSITIVITY OF THE MANUFACTURING COST OF GROUNDWOOD SLUSH PULP TO KEY VARIABLES

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N. SUMMARY AND DISCUSSION

1. Review of the Bases of Economic Analysis

The bases of this economic analysis and the methodology used were described in detail at the beginning of this volume (Sections A through D). Some of the key assumptions and cost bases of the analysis are summarized here for reference in interpreting the findings and to provide a rationale for the overall conclusions, as we have perceived them, that were derived from the specific findings.

a. Costs and Selling Prices

Almost all estimates of costs and selling prices used in this section were based upon mid-second-quarter 1974 values and included no allowance for future inflation. The major exception was waste paper; we did not believe that its prices in mid-second-quarter 1974 were indicative of long-term price trends. Accordingly, to estimate future prices, we developed cost models for waste paper collection, shredding, and baling; a markup was included to provide a return that we considered reasonable over the long run.

b. Pulp and Paper Manufacturing Cost Models

All estimates of investment cost, operating cost, and profitability pertain to a new grass-roots facility producing a single product on a single machine. If we had chosen to examine the economics of using secondary fiber (either exclusively or in a fiber blend) in existing mills, we believe that the comparison vis-à-vis virgin fiber would not have been as clear; the results would more likely have reflected the constraints or advantages of specific plants, such as size and type of equipment, market opportunities, and access to waste paper resources. We have considered opportunities for the use of secondary fiber in existing operations in a more generalized assessment of the recovery levels that might be achieved by 1983. (See Section X.) However, we have not attempted to postulate costs and profitability levels for an existing mill; this study was limited to a more generalized assessment of the future role of secondary fiber in the U.S. pulp and paper industry.

A separate but related characteristic of the cost models that should be noted concerns the unit sizes that we selected for the manufacturing facilities. For models using virgin fiber, the unit size is typical for a new installation; thus, while it does not always represent the largest size in existence or contemplated, it is selected to take advantage of the economies of large scale. We assumed that there was no constraint on the supply of pulpwood. For the secondary fiber models, on the other hand, the unit size selected for analysis was influenced by our intuitive belief regarding the incremental supply of waste paper available to support a new operation; the natural site for a new facility would be in a large metropolitan area, where another facility would probably already exist. Hence, we chose a low (perhaps even the minimum) economic scale of operation.

Clearly, an inherent bias is built into the calculated cost models as a result of the latter assumptions. It is axiomatic (and clearly shown in the sensitivity analysis for each cost model) that the potential profitability of the examples based upon secondary fiber would be increased substantially if there were sufficient waste paper to support a single larger machine, or if two machines using dissimilar waste paper grades were operating at the same site.

c. Profitability

The simple pre-tax return on fixed capital (ROI) was the only quantitative measure used to compare the profitability of virgin versus recycled fiber. In practice, of course, business decisions are based on many additional factors--cash flow, discounted rate of return, magnitude and availability of capital to fund new or expanded manufacturing facilities, market opportunities, and various other considerations. Many of these considerations are influenced by the economic and commercial situations of the individual firms; information on these situations is normally proprietary and difficult to incorporate within a generalized economic analysis. Nevertheless, implicit in the derivation of our overall conclusions drawn from the specific findings is a qualitative consideration of these other economic and commercial factors that influence the method by which a firm chooses to expand its production capacity.

2. Major Findings and Implications

(a) The unit size and capital requirement for an integrated virgin fiber pulp and paper manufacturing facility are an order of magnitude larger than for one based upon secondary fiber.

(b) The calculated ROI for the manufacture of newsprint and corrugating medium from secondary fiber is about equal to or slightly greater than that associated with the use of virgin fiber.

The ROI for the manufacture of jute liner (i.e., liner from secondary fiber) is substantially lower. Nevertheless, with a calculated ROI of 9% and the prospect of its increasing to about 19% if certain key variables were to reach possible highs (see Figure IX-E-6), this product appears sufficiently profitable to warrant more detailed examination of candidate sites.

Fiber blends and secondary fiber look particularly attractive for the manufacture of tissue and uncoated book paper. (See Tables IX-G-2 and IX-I-11.)

Table IX-N-1 summarizes the magnitude of the capital, capital intensivity, and scale of operation for selected paper and paperboard products.

TABLE IX-N-1

CAPITAL INTENSIVITY AND CAPITAL REQUIREMENTS FOR THE MANUFACTURE OF SELECTED PAPER AND PAPERBOARD PRODUCTS

Functional Group	Production (Metric tons) Daily	Production (Metric tons) Annual	Capital Requirements[a] $000/Daily Metric Ton	Capital Requirements[a] Total ($ Million)	Pre-Tax Return on Investment
CONTAINERBOARD					
Linerboard - Virgin	910	314,000	121	110	17.9%
- Secondary	300	100,000	100	30	8.7%
Corrug. Med. - Virgin	410	141,000	110	45	13.7%
- Secondary	300	100,000	80	24	11.8%
GROUNDWOOD PAPERS					
Newsprint - Virgin	1000	340,000	198	200	6.2%
- Secondary	300	102,000	133	40	10.6%
PRINTING & WRITING					
Bond Paper - Virgin	730	252,000	272	200	22.5%
- Secondary	136	45,000	220	30	4.2%

[a] Excluding woodlands

(c) The calculated ROI for some of the secondary fiber cost models is probably understated, because they are compared directly with commodity products made from virgin fiber on larger machines. In practice, the smaller machines using secondary fiber would probably be used to make the higher-added-value specialty items in their respective product categories; the short duration of the machine run would tend to offset the economic advantage of the larger machines using virgin fiber.

(d) The use of secondary fiber in the various functional groups would have unequal effects on the overall level of waste paper recovery. For example, a 5% increase in the S/F content of containerboard would result in a substantially higher tonnage of S/F reuse than a similar gain in any other functional group, because of the larger apparent demand (consumption) for containerboard.

Table IX-N-2 lists the functional groups and shows the proportion of U.S. paper consumption that each represents. Thus, it indicates the potential importance of each category in influencing the level of recycle.

(e) The relative importance of the various economic cost models should be recognized, since they clearly are not equally representative of the numerous products included in each functional group. For example, containerboard as a functional group represents 25.2% of total industry consumption. The two commodity grades we have selected for our economic models (linerboard and corrugating medium) represent 95.6% of the total functional group. Since they are commodity products, the economic models are applicable to the entire production, with the understanding that the models represent new installations and thus do not represent production costs for existing capacity.

Groundwood papers as a functional group represent 18.2% of total U.S. paper and board consumption. This functional group includes both a commodity (newsprint) as 86.1% of its total and specialty products (groundwood printing papers). Thus, our economic models for newsprint production are broadly applicable to new-capacity costs for a relatively large portion of the U.S. paper industry, whereas our uncoated groundwood printing paper models provide examples of new-capacity costs for a much smaller industry fraction.

Tissue and other machine creped paper at 4 million tons constitute 6% of the total U.S. consumption, while the specific box facial and roll toilet tissue considered in our cost model comprises roughly 45% of this functional group.

Printing and writing papers at 17.8% of total U.S. paper and board consumption are an example of specialty products. The grades selected for our models (bond paper and uncoated book paper) represent about 43% of the total functional group While the preceding cost models exhibit a range of quality variation, there is a wider range of quality variation within this functional group and even within the individual cost models.

TABLE IX-N-2

SUMMARY OF 1973 U.S. CONSUMPTION IN PRODUCT GRADES SELECTED FOR ECONOMIC MODELS

Functional Group and Grade	Consumption (000 tons)	% of Total U. S. Consumption all grades
1. Containerboard		
Linerboard	11,624	17.3
Corrugating Medium	5,300	7.9
2. Groundwood Papers		
Newsprint	10,500	15.7
Groundwood Printing Papers	1,700	2.5
3. Tissue and other Machine Creped Papers	4,000	6.0
4. Folding Boxboard		
Combination Board	2,763	4.1
Bleached (SBS)	1,755	2.6
5. Printing, Writing and Related Papers	11,900	17.8
6. Industrial Packaging, Converting & Misc.		
Packaging & Converting	5,270	7.9
Tube, Can & Drum	820	1.2
7. Construction Paper and Paperboard		
Construction Paper	1,800	2.7
Total U.S. consumption, grades represented by economic models	57,432	85.7
TOTAL U.S. CONSUMPTION, ALL GRADES	67,000	100.0

Accordingly, the models represent specific grades and are not applicable to the entire group.

In a similar manner, the relative importance of our specific cost models varies within each remaining functional group.

(f) The manufacture of secondary fiber products from pulp-substitute grades of waste paper presents a special economic problem. Unlike OCC and old news, which appear to be in abundant supply, only limited quantities of P/S grades are available. (See Section VII.) The shortage increases their selling prices and thereby reduces the potential profitability of recycling them.

So long as the P/S recycling operation competes with nonintegrated mills using market pulp, our calculations indicate that the S/F operation could remain competitive. (See Tables IX-G-13, IX-I-8, and IX-I-18.) Nevertheless, its overall profitability is not sufficiently attractive to justify the construction of new manufacturing facilities unless new sources of high-grade deinking and P/S grades are developed (or present ones are substantially expanded) to provide a low-cost cellulosic raw material.

(g) The sensitivity analyses of the studied examples indicates that the delivered cost of fiber and the scale of operation are the key cost variables. Other assumptions and cost estimates that are included in the cost model, such as the cost of energy or the amount of fixed capital required, are comparatively insignificant.

(h) The sensitivity analyses of the derived return on investment (ROI) indicate that selling price is by far the single most important variable. The mid-second-quarter 1974 prices that were used in the original calculations have increased significantly in practically every category during the preparation of this report.

(i) Transportation costs account for a sizable fraction of the total delivered cost of secondary fiber. If they could be reduced -- or even kept reasonably stable -- by such means as optimum site selection or the consolidation of shipments in and out of the mill, the profitability of practically all the secondary fiber examples would be significantly improved.

3. Conclusions

(a) Largely because of inflation, increased scale of operation, and anti-pollution regulations, the capital investment required for the construction of new grass-roots facilities more than doubled between 1969 and 1974. These rapidly rising capital requirements, combined with the lack of plant sites with adequate wood resources and the increasing cost and scarcity of market pulp, are making incremental expansion of secondary fiber pulping more attractive.

(b) Compared with a virgin pulp mill, a facility for repulping secondary fiber is generally less capital-intensive; thus it can be relatively small and still be economically attractive.

(c) The high cost of market pulp and the possibility of building a pulp mill based upon secondary fiber on a comparatively small economic scale provide potentially attractive opportunities for nonintegrated pulp mills, which have historically relied upon market pulp. As noted in Section VII, however, the shortage of suitable waste paper (namely, pulp-substitute and high-quality deinking grades) may be a constraint. In integrated mills, the use of secondary fiber instead of slush pulp is generally not as attractive as the replacement of market pulp in nonintegrated mills.*

(d) We have not presented economic models for the use of secondary fiber as fiber blends in existing integrated pulp and paper mills. However, the incremental production would clearly be attractive if the supply of virgin pulp were the constraining factor.

(e) Because the delivered cost of a recycled product is so dependent on the cost of waste paper and the scale of operation, any actions that stabilize the delivered cost of waste paper at a price competitive with virgin fiber or that increase the economic accessibility of waste paper, thereby permitting a larger scale of operation, will strongly encourage the use of secondary fiber.

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*This statement does not apply to the manufacture of newsprint or corrugating medium from 100% secondary fiber; the problem with these products is the availability of sufficient waste paper for an economic-sized operation. (See Section VII.)

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